CIVIL ENGINEERING

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A Span of 1883 Serving a City of 1933—Brooklyn Bridge, New York

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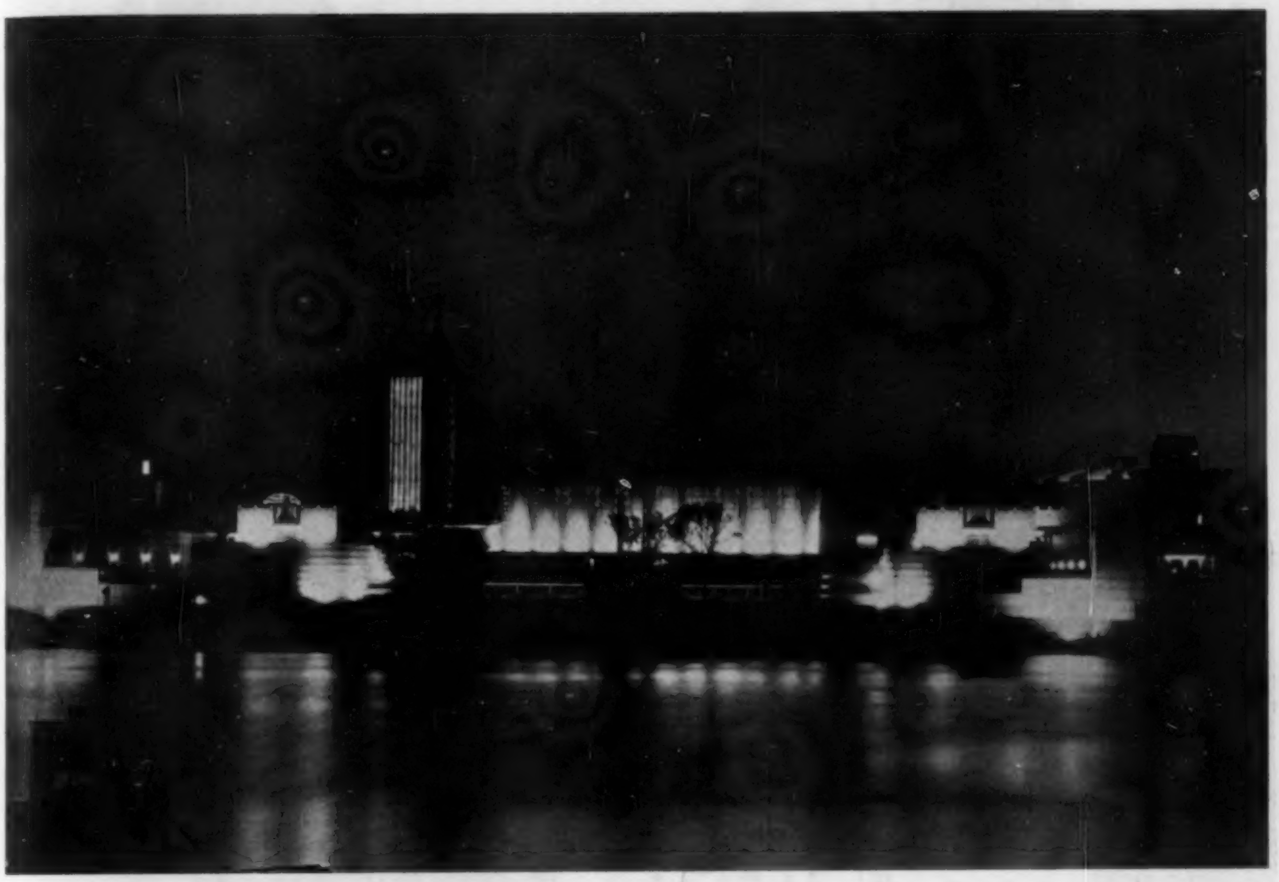

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Among Our Writers

Edward A. Byrne has been in the employ of the City of New York since 1886, when he was engaged on the construction of the Croton Aqueduct. From 1898 to date he has been connected with the Department of Bridges and its successor, the Department of Plant and Structures. As Chief Engineer since 1915, he has supervised the design and construction of ten draw-bridges and eight fixed bridges, including the Triborough Bridge not yet completed. He was a consulting engineer on the Holland Vehicular Tunnel and on the Philadelphia-Camden suspension bridge.

O. J. Todd gained his first experience in the Far West on the Hetch Hetchy Water Supply Project. In 1919 he went to China with the late John R. Freeman, Hon. M. Am. Soc. C.E. Of him Mr. Freeman wrote in 1931, "Todd is the most courageous man that I ever had working for me. Neither bandits nor hardships have any terrors for him, and he has continued in China doing wonderful work for famine relief all these ten years past."

Samuel B. Morris graduated from Stanford University in Civil Engineering in 1911. Since 1913 he has been Chief Engineer of the Pasadena Water Department. He has served successively as Secretary-Treasurer, Vice-President, and President of the California Section of the American Water Works Association, and for the past three years has been Director of the American Water Works Association.

John B. Drisko received his B.S. in Civil Engineering from the Massachusetts Institute of Technology in 1927. He then spent two years studying and traveling in Europe, Russia, and the Orient as a Traveling Fellow in Hydraulics from the Massachusetts Institute of Technology. Since 1929 he has been an assistant and instructor in civil engineering there, working in the River Hydraulics Laboratory.

Horace W. King, after graduating from the University of Michigan, practiced his profession for 17 years in the United States, Nicaragua, China, and the Philippine Islands. Since 1912 he has been Professor of Hydraulic Engineering at the University of Michigan. He is the author of the *Handbook of Hydraulics*.

Jasper H. Ings graduated from the University of Toronto in 1925. He has been with the Gatineau Power Company, of Ottawa, and with the Beauharnois Construction Company, of Beauharnois, Quebec, as a designer on hydro-electric developments, on bridge foundations, and air-caissons. During 1930–1932 he taught practical hydraulics in the laboratory at the University of Toronto.

I. Gutmann, Master of Science, University of California, started his career in 1915 with the Spring Valley Water Company of San Francisco, in charge of a two-year study of climatic, irrigation, and agricultural conditions around the Bay of San Francisco. He assisted the late Allen Hazen, M. Am. Soc. C.E., in research on the reconstruction of the Calaveras hydraulic-fill dam, and engaged in dredging and tideland reclamation in Suisun Bay. From 1919 to 1921 he consulted on hydro-electric irrigation and land reclamation projects in the Jordan River basin and the Plain of Sharon, in Palestine. From 1921 to 1926 he practiced water-works and sanitary engineering in New York City. Since 1927 he has been Associate Editor of the Engineering Index.

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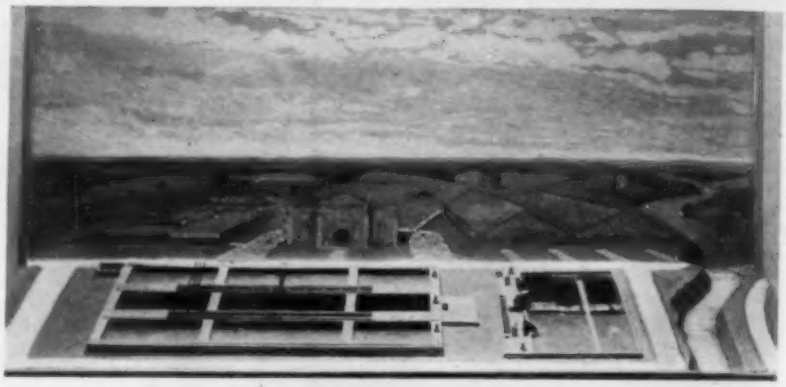

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Brooklyn Bridge—A Half Century of Service

Time Emphasizes Magnitude of This Achievement, Which Marked New Era in Engineering

By EDWARD A. BYRNE

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
CHIEF ENGINEER, DEPARTMENT OF PLANT AND STRUCTURES, NEW YORK, N.Y.

FIFTY years ago this spring, Brooklyn Bridge was formally opened—its span of 1,595.5 ft being considerably longer than that of any suspension bridge previously erected. In its time probably more was written about it in the technical and popular press than about any other bridge ever built, and deservedly so. Without attempting to discuss its engineering features, this article narrates the tremendous obstacles surmounted by its sponsors in promoting and financing the project. From the opening day it was evident that the structure would be profitable, as had been predicted at the outset by its designer, John A. Roebling. In a rush hour in 1907 the elevated railway over the bridge carried 46,256 persons, probably the greatest number ever handled by a double-track railway. Many new features were embodied in the design, among them the use of steel instead of iron for the cables. On May 24, 1933, a fitting celebration was held in New York to commemorate the opening of this monumental bridge just fifty years before.

CONSTRUCTION of a bridge over the East River, connecting New York and Brooklyn, which for so long was a fascinating problem to engineers and the general public, was suggested as early as the first part of the nineteenth century. At that time, however, engineering science had not been developed sufficiently to make it possible to design a structure of the required length, and capable of accommodating the traffic between the two cities. About 1840 considerable public attention was attracted to the subject, but as no definite steps were taken, interest waned.

Public zeal was revived in 1857 on the publication of a letter to Abram S. Hewitt, dated June 19, 1857, suggesting the feasibility of a bridge between the two cities, so constructed as to preserve unimpaired freedom for navigation. This letter was signed by John A. Roebling, M. Am. Soc. C.E., who had completed a suspension bridge over the Niagara River three years before.

Following the agitation in 1857, no immediate progress was made and the Civil War necessarily diverted the attention and activities of the people. After the war, however, interest in the project was again revived. A strong impetus was given the project in the winter of 1866–1867, when the East River was so choked with ice as to render transportation by water at times nearly impossible. A popular and vehement demand arose for the immediate construction of the bridge, and the newspapers took up the subject with fervor. As a result, on April 16, 1867, Chapter 399 of the state laws was passed, entitled "An act to incorporate the New York Bridge Company, for the purpose of constructing and maintaining a bridge over the East River, between the cities of New York and Brooklyn."

The Committee on Plans and Surveys of the company thus authorized selected John A. Roebling as Chief Engineer of the proposed bridge, his appointment to take effect on May 23, 1867. The committee reported that it was guided in its choice by the consideration that the construction of a suspension bridge of unprecedented magnitude demanded the greatest experience and mature ability that could be obtained. After making inquiries and holding conferences, the committee was satisfied that the constructor of the Niagara River suspension bridge and of the Ohio River suspension bridge at Cincinnati was the person they sought. The Niagara River Bridge, having a main span of 825 ft, was completed in 1854 and the Ohio River Bridge, with a main span of 1,057 ft, was completed in 1867. The committee stated that confidence on the part of the public and of those whose money was to be invested in the undertaking would best be ensured by employing the engineer who had achieved the most successful results up to that time and who was thus most likely to carry this great enterprise through to completion.

NEW YORK ANCHORAGE UNDER CONSTRUCTION
Completed in July 1876

The Chief Engineer then made the necessary surveys and prepared plans and estimates of cost. He reported on three sites: the City Hall Park line or route, the Chatham Square route, and the Bowery-Canal Street route. He recommended the City Hall Park line

because it would command the uptown travel and the greater part of the downtown travel, and thus do a full and remunerative business at the outset, in competition with the ferries. Mr. Roebling also declared that if a

AT THE BROOKLYN ANCHORAGE, OCTOBER 1878

Left to Right: Henry C. Murphy, President; John H. Prentice, Treasurer; William H. Paine, Assistant Engineer; C. P. Quintard, Secretary; William van der Bosch, Draftsman; William Dempsey, Foreman of Riggers; W. Hildenbrand, Chief Draftsman; E. F. Farrington, Master Carpenter; Charles G. Martin, First Assistant Engineer; F. Collingwood, Assistant Engineer; George W. McNulty, Assistant Engineer

first bridge were built, a second and a third would follow sooner or later. The second one, he suggested, should connect Williamsburgh in Long Island, and a proper route for the third would be across Blackwell's Island (now called Welfare Island). If the first bridge were built on the City Hall Park line, it would not lose as much traffic when the second bridge was erected as if it were located farther north. The estimated cost of the bridge was given as $7,000,000, exclusive of the cost of land for the approaches.

In October 1867, the Committee on Plans and Surveys recommended for adoption the route having its westerly terminus at City Hall Park. In regard to the structural plan of the bridge submitted by Mr. Roebling, the committee recommended its adoption subject to such modifications as further study might make advisable.

The City of Brooklyn subscribed for stock to the amount of $3,000,000 and the City of New York to the amount of $1,500,000, and each city was given three representatives on the Board of Directors of the New York Bridge Company. The reason for the larger subscription on the part of Brooklyn was that the bridge would be more beneficial to it than to New York. In all, 50,000 shares, at a par value of $100, were sold.

An act was passed by the Congress of the United States and approved on March 3, 1869, to establish the bridge, when completed, as a lawful structure and post road. The act also provided that the bridge should not obstruct, impair, or injuriously modify the navigation of the river, and that its plan and location should be submitted to the Secretary of War for his approval.

At the request of Mr. Roebling, a commission of engineers was authorized by the bridge company in January 1869 to review his plans, as he considered it right and proper that they should be subjected to careful scrutiny by a board of experienced men. Seven of the most eminent engineers of the profession were invited by Mr. Roebling to sit in judgment on his work. In May 1869, after three months of careful deliberation, they issued a unanimous report "that it is beyond doubt entirely practicable to erect a steel wire suspension bridge of 1,600-ft span, 135-ft elevation, across the East River, in accordance with the plans of Mr. Roebling, and that such structure will have all the strength and durability that should attend the permanent connection by a bridge of the cities of New York and Brooklyn." This board of consulting engineers consisted of Horatio Allen, Past-President Am. Soc. C.E., Chairman; William J. McAlpine, James P. Kirkwood, and Julius W. Adams, Members Am. Soc. C.E.; and Benjamin H. Latrobe, John J. Serrell, and J. Sutton Steele. Previously Mr. Adams had severely criticized the design as unsound.

A commission consisting of three Army engineers, appointed by the U.S. War Department to report on the bridge from the point of view of navigation, as well as on the general feasibility of the project, on May 22, 1869, submitted its report to the Chief of Engineers of the U.S. Army. This commission recommended an increase of 5 ft, from 130 to 135 ft, in the clear height of the bridge and stated that there was no doubt of the entire practicability of the structure or of its stability when completed. A communication dated June 21, 1869, was received by the bridge company from Brig.-Gen. A. A. Humphreys, Chief of Engineers, stating that the Secretary of War, John A. Rawlins, had approved the plan and location of the bridge with this increase in height.

DEATH OF JOHN A. ROEBLING

The plans for the structure having been accepted and approved, Mr. Roebling, who had now won the confidence and hearty support of the public, felt justified in proceeding with the construction work. On June 28, 1869, when he was making surveys on the Brooklyn front of the river, a boat coming up to the bulkhead caused his right foot to be caught between the timbering, crushing his toes. He was taken to the house occupied by his son, Col. Washington A. Roebling, who was associated with him in the bridge work and was then living at 137 Hicks Street, Brooklyn. At first his condition was not considered serious, but later tetanus developed with fatal effect, and he died on July 22, 1869, at the age of 63 years.

In a tribute to his genius, one of his biographers, Charles B. Stuart, summed up his character: "One of his strongest moral traits was his power of will, not a will that was stubborn, but a certain spirit, tenacity of purpose, and confident reliance upon self, that was free of conceit; an instinctive faith in the resources of his art that no force of circumstance could divert him from carrying into effect a project once matured in his mind.... Before entering upon any important work, he always demonstrated to the most minute detail its practicability, to his own mind at least, by scientific experiment and critical test; and when his own judgment was assured, no opposition, sarcasm, or pretended experience, could divert him from consummating his designs, and in his own way."

The death of John A. Roebling necessitated the immediate choice of a successor, and his son, Col. Washington A. Roebling, M. Am. Soc. C.E., was appointed Chief Engineer on August 3, 1869. For years the son had shared in the father's professional confidences and activities, and did not therefore succeed him by inheritance merely. According to his own statement, the elder Roebling would not have undertaken the conduct of this work at his age if it were not for the fact that he had a son who was entirely capable of building the bridge. However, the main designs were practically completed before the elder Roebling met his untimely death. It remained for the son to carry on the work so sadly interrupted.

On October 14, 1869, William C. Kingsley, Fellow Am. Soc. C.E., was appointed General Superintendent of the work. He had been active in promoting the project and had given unsparingly of his time and energy

in getting the bridge started. Just as the inception and leading features of the work were due to the genius of John A. Roebling, so the enormous labor connected with the preliminary legislation and organization was credited to the effort of Mr. Kingsley.

CAISSON CONSTRUCTION DIFFICULTIES

On October 25, 1869, in pursuance of a resolution of the Board of Directors, a contract for building the timber caisson for the Brooklyn tower was awarded to Webb and Bell, and work began immediately. This was the first construction done on the bridge. The caisson, which had a length of 168 ft and a width of 102 ft, and was the largest ever built up to that time, was towed to the site on May 3, 1870. Building of the caisson for the New York tower was commenced in October 1870. This caisson, which was also built by Webb and Bell, was slightly larger—172 ft long by 102 ft wide.

The sinking of these caissons entailed many hazards. The caisson for each foundation was a large inverted vessel or pan, resting bottom upwards, and having strong sides, into which air was forced under a sufficient pressure to drive out the water. It was necessary to increase the air pressure as the sinking progressed to a suitable and satisfactory bearing strata, as previously determined by test borings. The men working in the air chambers were required to be of sound physical make-up to withstand the effects of confinement under pressures greater than atmospheric. Every precaution in avoiding violent exertion, and even climbing of ladders was recommended to reduce the possibilities of contracting the dreaded "caisson disease." Its symptoms were nervousness and excitement, causing excessive action of the heart and thus accelerating the general tendency to paralysis. Shorter working periods were adopted to reduce the danger to the men.

In addition to danger to workmen from the compressed air there was the ever-present danger of fire, since illumination in the caissons was by candles, by calcium lights using oxygen gas, and by illuminating gas. Several fires, one of serious proportions, requiring the assistance of the fire department, were discovered in the Brooklyn caisson and by the heroic efforts of those working in the air chamber, including Colonel Roebling, were extinguished. Exceptional care had to be exercised to avoid the recurrence of such fires.

During this work Colonel Roebling devoted nearly all his time to directing the efforts of his men, mindful always of the fact that any slip, no matter how trivial, at this stage of the work might prove disastrous. He spent more hours in the compressed air of the caissons than anyone else, wore out his strength, and one afternoon in the spring of 1872 was brought up out of the New York caisson nearly insensible, suffering from an attack of "caisson disease," which had already proved fatal to several of the workmen. For many weary years, this man, who was full of life, hope, and daring at the inception of the work, was an invalid, confined to his home. Although his nervous system was shattered, his mind was not affected; indeed, his intellect appeared to be quickened, for realizing how incomplete the plans and instructions for the completion of the bridge were at that time, and fearful that he might not live to finish the work himself, he spent a large part of his time in his sick room writing and drawing. His papers contained the most minute directions for making the cables and for the erection of all the complicated parts that compose the superstructure.

In all justice to the man himself, who readily acknowledged the facts, the work could not have been accomplished but for the unselfish devotion of his assistant engineers. Each one had charge of a certain part of the work and they all gave their full energies to the proper accomplishment of their assignments in accordance with Colonel Roebling's plans and wishes. Charles C. Martin, M. Am. Soc. C.E., Engineer in Charge, had general supervision of the whole work. Col. W. H. Paine, Francis Collingwood, George W. McNulty, and Samuel R. Probasco, all Members Am. Soc. C.E., were assistant engineers in charge of construction on various parts of the structure. Wilhelm Hildenbrand, M. Am. Soc. C.E., was Engineer in Charge of the Drafting Room, and E. F. Farrington was Master Mechanic. All these men were engaged on the bridge from its inception to its completion. Colonel Roebling acknowledged his everlasting gratitude for their splendid cooperation and unhesitatingly credited the ultimate success of the work to their ability.

By two acts of the state legislature, in 1874 and 1875, the control of the bridge was transferred from the New York Bridge Company to the cities of New York and Brooklyn.

The masonry tower in Brooklyn was completed in June 1875, and the masonry tower in New York in July 1876. The Brooklyn anchorage, which had been commenced in February 1873, was completed in October 1875; and the New York anchorage, started in October 1871, was finished in July 1876.

CONSTRUCTING THE CABLES

In the summer of 1876 everything was in readiness for the engineers to enter upon what seemed to the public the most picturesque as well as the most ingenious stage of their task—the erection of the temporary footbridge across the river and the spinning of the main bridge

WIRE CABLES UNDER CONSTRUCTION
Last Cable Wire Was Run in October 1878

cables. The first wire rope for the temporary footbridge was run over on August 25, 1876.

The Board of Trustees, at its meeting on January 15, 1877, authorized the award to J. Lloyd Haigh, of New York, of the contract for furnishing and delivering the steel wire for the main cables, at a price of \$0.087 per lb, he being the lowest bidder for crucible-cast steel wire. The first cable wire was run on April 5, 1877, and the last on October 5, 1878.

Of much interest in this connection is the following abstract from a letter written by Colonel Roebling, at the age of 88, to the Secretary of the Society:

The main cables were not only much larger than those of the

Cincinnati Bridge, but were the first ones made of steel wire, involving new methods of splicing wire and an increased number of strands composing the cable and greater difficulty in their regulation.

The superstructure was at first intended to be of iron, even up to the time when specifications were written, but was at the last moment changed to steel, thereby reducing the total dead load by a considerable amount.

On December 1, 1882, as the bridge was nearing completion, the President of the Board of Trustees, Henry C. Murphy, died. He devised the legislation under which the bridge was commenced and upheld its feasibility and utility before committees, legislatures, and law courts, and in every form of public discussion.

BROOKLYN BRIDGE IN 1933, LOOKING TOWARD MANHATTAN

As President of the New York Bridge Company and later as President of the Board of Trustees, his personal oversight was given to every stage of the enterprise.

During the erection of the superstructure the work was impeded to a great extent by the rapid depletion of the funds of the Trustees. Time and time again it was necessary to make application for additional moneys to carry on the work. Because of the increased cost of the structure made necessary by the change in its design as the work progressed, and the increase in prices of material on account of the delays incidental to the prosecution of the several contracts, much criticism was directed by the public and press toward the management of the enterprise, and a good deal of blame was thrown on the shoulders of the engineers. Colonel Roebling, being physically incapacitated and therefore unable personally to direct the work, was charged by some of the Trustees as being the cause in great measure of the tardy completion of the bridge. In the summer of 1882 an attempt was made to displace him as chief engineer.

To place the blame on him for the attendant delays because of failure to continue the delivery of material was a charge which Colonel Roebling felt constrained to disprove. He showed to the satisfaction of the majority of the Trustees, who supported him, that even though his absence from the work gave rise to suspicions of neglect of duty, his constant thoughts and instructions, capably carried out by efficient assistants, would carry the bridge to completion more rapidly than if there were a change in the personnel of the organization. He contended that to appoint some other man as chief engineer, even though he had great ability and reputation, might long defer completion of the bridge. He knew full well that engineers, like other professional men, do not always agree and that a new chief engineer might desire to make changes in the plans.

To assuage his feelings, in the event of his removal, his antagonists offered to name him as consulting engineer, but he insisted that under no circumstances would he accept any position except that of chief engineer. If they removed him, they would have to do it absolutely. Ably supported by Mr. Murphy and Mr. Kingsley, the resolution to supersede Colonel Roebling was defeated by a vote of 10 to 7 in the Board of Trustees, and he remained Chief Engineer until completion of the bridge.

In connection with Colonel Roebling's defense charges, it is of interest to mention the assistance rendered him by his wife, whose devotion and tact when he was almost helpless physically, kept him in communication with the work through its several stages. He dictated to her a statement telling what he was doing on the bridge and why he should not be displaced, and this she herself read before a meeting of New York engineers in the American Institute Fair Building at Third Avenue and 63d Street, producing an immense sensation. It was a splendid statement and was well received by the public. Her self-sacrificing devotion to him and his work and the profound intelligence that she displayed greatly aided in the consummation of his ideas.

The completion of the bridge and its opening to the public on May 24, 1883, was recognized as an event of national importance. Throughout the country the opening ceremonies were regarded with great interest. Nearly every state contributed its representatives to the throng that attended the opening. The day was clear and the cities were decorated in gala attire; business was generally suspended and the people turned out in mass. Excursions run by the railroads brought many sightseers from neighboring cities and towns.

PRESIDENT AND GOVERNOR TAKE PART IN OPENING

Early in the afternoon, the President of the United States, Chester A. Arthur, and the Governor of the State of New York, Grover Cleveland, the former accompanied by members of his Cabinet and the latter by officers of his staff, were escorted from the Fifth Avenue Hotel in New York to the New York City Hall, where they were met by the Mayor of New York, Franklin Edson, and other New York City officials. From the City Hall the procession made its way to the bridge, accompanied by the Seventh Regiment of the National Guard of the State and a band of 75 pieces, and walked across the bridge on the promenade. At the New York Tower, a battalion of the Fifth U.S. Artillery joined the escort. The arrival of the procession at this point was proclaimed to the multitudes on shore by the thundering of many cannon. Salutes were fired from the forts in the harbor, from the U.S. Navy Yard, and from the summit of Fort Greene. Five boats of the United States fleet, anchored in the river below the bridge, joined in the salute. At the Brooklyn side, the escort was transferred to the 23d Regiment of the State National Guard.

The opening exercises were held in the railway terminal at the Brooklyn end of the bridge. Besides the President and his Cabinet and the Governor of New York and his staff, there were present governors of several states, the mayors of nearly all the cities in the vicinity, and many Army and Navy officers. At the ceremonies, James S. T. Stranahan, one of the Trustees, presided.

After the exercises, the President, the Governor of New York, the speakers of the day, and the Trustees were driven to the residence of the Chief Engineer, Washington A. Roebling, on Columbia Heights, Brooklyn, to offer him their felicitations on the completion of the bridge. At night there was an elaborate display of fireworks on the bridge; a reception was given to President Arthur and Governor Cleveland in the Academy of Music in Brooklyn; and buildings were illuminated and concerts held in various city parks.

The construction of this bridge, which was so vital to the interests of both cities, entailed an expenditure greatly in excess of the original estimate of $7,000,000, exclusive of land. Up to May 31, 1883, the cost amounted to $15,211,982.92, of which $483,299.77 was for the acquisition of privately owned stock of the New York Bridge Company; $3,886,544.53 for the acquisition of property; $504,572.07 for engineering services, and $10,337,566.55 for construction, equipment, and miscellaneous items. At that time $23,141.74 was due on contracts. The increase in the cost of construction over the original estimate of John A. Roebling was caused by an increase in the size and clear height of the bridge, by changes in the plans made necessary as the work progressed, by the increased cost of materials and labor, by losses occasioned by delays in construction, and by various incidental charges not originally contemplated.

THE CHIEF ENGINEER RESIGNS

Colonel Roebling resigned as Chief Engineer on June 30, 1883, and his principal assistant, Charles C. Martin, M. Am. Soc. C.E., was appointed Chief Engineer and Superintendent.

The local railway, with cars operated by endless wire cables driven at a rate of 10 miles per hour, was opened for use in September 1883.

In order to double the facilities for railway traffic, which were inadequate, plans were prepared in 1892 for building new and enlarged stations—one at the New York Terminal and one at the Brooklyn Terminal—and for extending the car storage yard from Concord Street to Tillary Street in Brooklyn, and duplicating the cable driving plant.

At a meeting of the Board of Trustees held in October 1896, the matter of transit of elevated and surface cars over the bridge was referred to a board of engineers consisting of Leffert L. Buck, Virgil G. Bogue, and George H. Thomson, all Members Am. Soc. C.E. Their report, made in February 1897, stated that it was feasible and practicable to operate cars or trains of the elevated railroads on the bridge and also to operate surface cars on the roadways, spaced at least 102 ft apart.

In August 1897 an agreement was made between the Trustees and the Brooklyn Elevated Railroad Company and another with the Kings County Elevated Railway Company to permit their operation of elevated trains from Brooklyn across the bridge to the New York Terminal. Agreements were also made in August 1897 with four surface railway companies for operation of surface cars across the bridge to the New York Terminal.

The use of the hauling cables for bridge local trains was entirely discontinued in January 1908. In accordance with the agreements with the elevated and surface railway companies, these companies pay the city for the privilege of operating railway cars across the bridge.

By ordinance of the Board of Aldermen, effective January 26, 1915, the name of the bridge was changed from New York and Brooklyn Bridge to Brooklyn Bridge. As a matter of fact the bridge had been called the Brooklyn Bridge from the beginning by the general public although this was not its official name.

Before New York and Brooklyn were permanently connected by the Brooklyn Bridge, serious thought had been given to the union of the twin cities under one name and government. It can be reasonably said that the completion of the bridge, with its attendant shift of population, aroused greater interest in this union and hastened the consolidation of the cities, which took effect on January 1, 1898, after enactment of the Greater New York Charter in May of the previous year.

When the actual construction of the bridge was started in the latter part of 1869, the population of Brooklyn was 395,000 and that of New York was 940,000. Many people took advantage of the proposed improvement to establish homes and commercial enterprises in Brooklyn. At the time of the opening of the bridge the population of Brooklyn had increased to about 650,000 and that of New York to about 1,300,000. After the bridge was opened and ready transit was afforded between the two cities, both continued to grow, as shown in the census of 1890, when the population of Brooklyn was 838,000 and that of New York, 1,515,000. The assessed valuation of real property in the City of Brooklyn—$183,000,000 in 1870—rose to $220,000,000 in 1880 and to the astounding sum of $430,000,000 in 1890. By 1895 it had reached a total of $540,000,000.

View from the Brooklyn Terminal
Cable Operation for Bridge Railway Discontinued in 1908

The development of the bridge railway was marked by great increases in traffic until passenger traffic across the bridge decreased as other rapid transit routes between the two boroughs were opened. Beginning in 1883 with one- and two-car trains hauled by cable over the bridge and switched in the terminals by steam locomotives, the service developed to four-car trains in 1897, hauled by cable and switched by electric power and operated in rush hours on a headway of one minute between trains. The trains were increased to five cars in 1906 and to six cars in 1908. The count of traffic for one day of 24 hours showed a maximum in the year 1907 of 265,636 persons using the elevated railway, with a rush-hour traffic of 46,256 persons. The carrying of such a large number of people in an hour has never been accomplished by any other double-track railway in the world.

In 1884, on a typical day, there were 25,300 people carried across the bridge on the railroad cars then operating, and in 1907, before the opening of the Manhattan Bridge close by and the first rapid transit subway under the East River, a count for one day showed 410,467 transported in elevated and surface cars.

The Brooklyn Bridge has now been in use for 50 years. On many occasions, the question arose as to whether or not it was adequate to meet the demands of traffic. Several reports were made by bridge engineers outside the city service, and in all cases they agreed with those of the department engineers that the structure was safe. The builders of the bridge took every precaution in its erection to make sure that all materials and workmanship were of the best. The safe and satisfactory action of the structure even with the increased moving loads due to heavier railway cars and vehicles and the addition of trolley cars, not originally contemplated, shows that the constructors builded better than they knew. There is every reason to believe that the bridge, if carefully maintained and not overloaded, will continue its usefulness indefinitely.

Wrestling with Some of China's Rivers

Both Medieval and Modern Engineering Methods Applied to the Yangtze, the Yellow, and the Yung Ting

By O. J. Todd

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China has a stupendous flood control problem. In spite of various corrective efforts covering centuries, some Chinese rivers still wander almost at pleasure, often cutting back of important towns along their banks. After studying these problems for 14 years at first hand, Captain Todd has developed methods of coping with them as here described. To American ideals of construction, he has adapted age-old Chinese operations, such as tamping great dikes by hand with that extraordinary device, the "flapper," driving piles with a four-man hammer, digging clay for embankments out of river beds by hand under three feet of water, and transporting rock for revetment over a hundred miles in small junks. Among his most outstanding achievements was the turning of the entire Yellow River back into the bed it had deserted, a unique feat.

After every great flood in China, and at intervals between, commissions are formed and investigators put into the field to make studies in the hope that a way may be found at a reasonable cost to protect large tracts of river valley lands. This has been the rule except in the regions close to Tientsin and Canton, where foreign engineers have made rather comprehensive studies. Able men have been invited in from time to time to remain a few weeks and then pass from the scene, after only preliminary studies of the Yangtze, the Hwai, and the Yellow rivers (Fig. 1). On the whole, therefore, China's great river problems remain unsolved and little permanent work has been done on comprehensive flood prevention programs, though in particular cases some valuable preliminary studies have been made.

For irrigation also, little has yet been accomplished even on the principal feeders, though a start has been made. The silt problem has been found to be a factor of consequence, of such moment as to discourage attempts by engineers to build any impounding reservoirs along many of the northern tributaries.

Fortunately the China International Famine Relief Commission, with which I am connected, has committees in many of China's provinces so that cordial relations exist with local authorities, making it possible for us to operate where private companies could not, in view of the political instability that has existed for many years.

As is known to students of river problems, the Yellow River comes from snow-capped ranges near the borders of Tibet and on the whole flows through an area of rather light rainfall, getting its floods from rapid run-off due to the rains of July and August. The large feeders come in from the provinces of Shensi and Shansi (Fig. 1), where the loess-covered hills furnish the fine silt that gives the river its name. It is a dark yellow silt very different from the red clay that plays such a large part in coloring the Yangtze. Geologists tell us that for ages this fine silt has been blowing in from the northwest to cover the hills of Kansu, Shensi, and Shansi from 100 to 500 ft in depth. It fertilizes fields but it also clogs irrigation ditches.

Finally the river dumps its mud load into the Gulf of Chihli, where it keeps building out its delta farther and farther eastward each year. Unfortunately the Chinese Government does not keep careful records to show the rate of advance. During the 500 years that this river flowed into the sea near Haichow, 500 miles to the south by the coast line (Fig. 1), it so discolored that arm of the ocean that navigators named it the Yellow Sea. The river silts its own bed in the autumn at the time of falling flood, so that only boats of shallow draft can be used, even along the lower 100 miles. Steam-launch service is unknown anywhere along it, except for a single mile at the railway bridge in Shantung. A deep channel is scoured each summer in flood time with increased hydraulic radius and velocity, but resilting soon brings the bed up to its old low-water level, forming a shallow, meandering stream with a minimum flow of about 10,000 cu ft per sec. A flood flow over ten years ago was estimated at 350,000 cu ft per sec; the extreme maximum probably never exceeds 500,000 cu ft per sec.

In the lower stretches of the river, in Shantung, samples of water at flood time have shown a solid content of 12 per cent by weight. At Tengkow, Suiyuan, however, at a point above all the tributaries from Shansi and Shensi, the maximum silt load found during the past three years has been 4 per cent by weight. On the King River, whose waters flow into the Wei River and then join the Yellow River near Tungkuan, Shansi, the silt load last summer was as high as 48 per cent by weight.

The rapid deposition of silt under conditions of low velocity and the value of most of it as a replenisher of farm lands, make the handling of the rivers of North China most interesting. The storing of the mud-laden waters in reservoirs for irrigation purposes has not been attempted because of the likelihood that these structures would become practically useless within a few years, before they had paid for themselves. Certain tributaries known to have considerable exposed rock on their watersheds will be used in the first storage experiments.

Junks on the Yellow River
Fleet of 300 Brought Rock for Li Chin Dam 100 Miles

Along the lower 100 miles of the Yellow River there is little bank protection of stone. The dikes are of earth lined with willow trees, which are often cut and used as tree retards in time of danger when a current starts to undercut a bank that was previously considered safe. At dangerous points the *kaoliang pak* groin has been used successfully for years and seems the cheapest contrivance for protecting earth banks from erosion. The *kaoliang* is a native plant resembling corn but somewhat taller. The stalks, nearly 10 ft long, are pulled up with the roots attached and

brought to the river dikes in great quantities. With the roots toward the water and the stalks laid down symmetrically at right angles to the bank line, alternate 6-in. layers of stalks and earth are placed until the *pak* reaches a height of one or two feet above the dike. To hold these groins in position, two willow stakes each 3 ft long are crossed at the river face at the top of each 3-ft layer and tied back to heavy anchor stakes in the dike by 2-in. hemp rope made on the job. As these groins settle with age new layers are placed on top. They successfully stop erosion by summer floods, but an ice jam sometimes cuts them up badly. During ice flows large willow poles are fastened to them in a vertical position as a protection from tearing.

It was in this region of earth dikes and only scanty *pak* work that the north banks were cut by the flood waters of August 1921 at a point near Li Chin, Shantung, and the Provincial Dike Bureau found itself unable to plug up the breach (Fig. 2). The old method was to place a great load of *kaoliang* stalks weighted with earth on top of a cradle made of twenty to thirty 2 or 3-in. hemp or bamboo ropes stretched across the breach, and then to lower this plug into the opening while hundreds of men rushed in with baskets of earth to make it water-tight. But this method failed here, and the breach grew despite efforts with *kaoliang* and stone. When the flood receded the river had changed its course and was going through this gap in the bottom of a U-bend. It had spread itself over a broad territory, dispossessing 250,000 farming people.

PLAN FOR RECAPTURING RIVER

To throw the entire Yellow River back into its old bed called for special measures and a considerable expenditure. Funds for this were not made available until a second summer's flood had widened the breach to nearly a mile. On the invitation of the Governor of Shantung, I then devised a plan (Fig. 2) that was carried through the following winter and spring so that in July 1923 the Yellow River was again flowing in its old bed. This required methods new to China and the use of both native and foreign equipment, a fleet of over 300 native boats or junks for several months, a working force that reached a peak of nearly 25,000 men, and a knowledge of the habits of the river.

The plan included a rock-fill dam across the river just below the upper end of the U-bend or ox-bow and a cut-off leading channel 6,000 ft long and 500 ft wide, with dikes 900 ft apart. This channel was dug across the top of the U-bend to lead the main flow back into the stretch of the old river bed below the break. It was also necessary to clean out a scouring channel 100 ft in width for seven miles down the old river bed just below the point where the leading channel entered it. In addition, various supplementary dikes were needed to keep the river within the intended course.

Since it was not certain at how low a stage we would be able to close the breach, the design of the trestle from which to work was somewhat conservative. The plan I had drawn up in the autumn of 1922 was carried out in practically all its details, and the river behaved as was expected. The actual diversion was made in mid-May 1923, with the river flowing at 15,000 cu ft per sec. This seems to be the only time recorded in history that a dam has been placed across the Yellow River to deflect its entire flow to a new course after it has established a fixed channel.

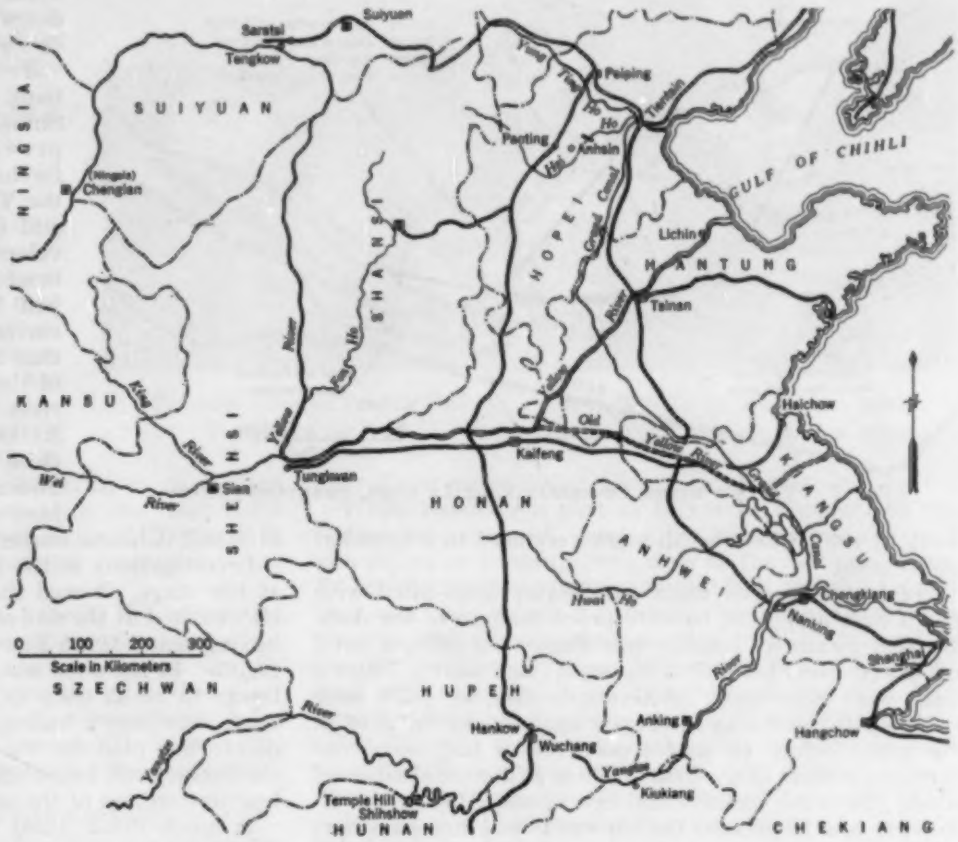


FIG. 1. MAP OF NORTH AND CENTRAL CHINA

The rock-fill diversion dam was built from a very substantial pile trestle 800 ft long and 28 ft wide on the working floor. The pile bents, spaced 10 ft apart, were driven by a steam pile driver brought especially from the United States. The piles varied from 40 to 65 ft in length, the longer ones being shipped from the United States after all available 12 by 12-in. Oregon pine timbers of suitable length in the China market had been purchased. A minimum of 20 ft of penetration was required, the average being about 25 ft. Four piles were used to the bent, with a 12 by 12-in. cap drift-pinned across each set with a short overhang. Then two diagonal cross braces, 3 by 10 in., bolted to all the piles, made the sets rigid. The longitudinal stringers connecting the pile bents carried four tracks of a light railway and ample runways for the workmen.

Weeks before, one-man sized rock had been quarried a hundred miles upstream, brought down in junks, and piled close by. From this material, gangs of men working day and night loaded 40,000 cu yd on push cars and dumped the core of the dam direct from the trestle.

To prevent undue loss of rock from settlement into

the soft river bed, a woven wire-mesh mattress was placed beneath the rock fill and carried well below the dam proper to support the apron. Probably there was no great need of this, as seemed to be the final conclusion of the engineers on the lower Colorado River diversion work of 1907, where brush mats were used to a considerable extent.

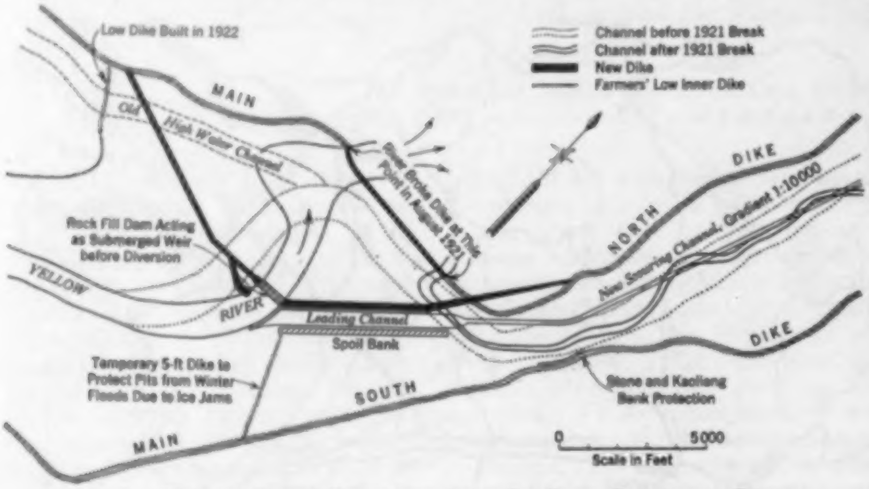


FIG. 2. YELLOW RIVER DIVERSION NEAR LI CHIN, SHANTUNG, CHINA

Native-made reed mats and burlap bags filled with earth were employed to waterproof the face of the dam. By this means all leakage was finally cut off. A total of 10,000 mats (over 300,000 sq ft) and nearly 300,000 bags were thus used. Afterwards *kaoliang paks* were built up in places as insurance against sudden rises of the river before an ample earth cover had been constructed in front of the dam. These *paks* were also placed along the north bank of the new channel below the diversion dam to prevent the current from cutting in there while a deep channel was being scoured out by the river below the 12 ft of hand cutting.

The entire work of turning the river into its old bed at this point was accomplished well within my estimate of $1,500,000 (Chinese currency). Of this sum, Shantung Province provided 75 per cent and the China International Famine Relief Commission gave the remainder, since the work was directly connected with famine prevention and food supply insurance. As this work drew to a successful close in the summer of 1923, the Famine Commission invited me to enter its service as chief engineer and build up an engineering department. Some of my further experiences on China's rivers while serving in this new capacity may be of interest to American engineers.

WORKING WITH THE YANGTZE

Before speaking further of the Yellow River and its feeders, attention may be called to some contrasts between it and the Yangtze. This largest river of China has a maximum theoretical flow of about 3,000,000 cu ft per sec, or much the same as our own Mississippi. Its discharge at Hankow at the height of the flood of August 1931 was estimated at 2,800,000 sec-ft, its greatest flow within the memory of living engineers.

A few experiences will serve to show the difficulty that China faces in trying to cope with the flood problems along its reaches. These are projects undertaken for the Famine Commission working with national and provincial authorities. The first was in 1925 at Temple Hill, in the Shihshow district of Hupeh, nearly 300 miles above Hankow on the south bank of the river (Fig. 1).

Its large volume of flow and deep cutting channel make the Yangtze formidable. Though the silt of its middle and lower valley contains much clay, and is not eroded nearly as readily as the loess of North China, along the Yellow River, yet it slides when thoroughly soaked. Then it dissolves and goes down to the sea or is deposited downstream in shoal waters.

Temple Hill lies along the south bank of the Yangtze at the town of Shihshow. It acts as a great groin to prevent the river from moving farther to the south. In this region the Yangtze is constantly wandering and for a number of years has developed and maintained five great bends in the 30 miles of its length just below this hill. In 1918 the current in flood time was so strong that it cut the south dikes just east of the hill and inundated an area of river-bottom farm land totaling over 30,000 acres. Various attempts to close this breach failed until we undertook and completed the work here described in 1925 at a cost of $150,000 (Chinese currency).

Investigations in the late winter, when the river was at low stage, showed that alternate layers of sand and clay existed at the site of the old dikes due to the river's having many times flowed across this path in past centuries. In the flood water channel borings showed these layers to be as deep as 12 or 14 ft. At flood heights there was heavy leakage through the base of the old dike. My plan for the new dike therefore included a clay core, well below the ground surface, through the heaviest section of the work.

A muck ditch 3,500 ft long was first excavated 10 ft wide and from 8 to 10 ft deep along the center line of the new dike. After interlocking wooden sheet piling had been driven on the shore face of this core to depths varying from 10 to 14 ft, the core was built up from carefully selected clay rammed in 6-in. layers. This clay core, begun in the muck ditch, was carried up through the dike to the top. A well selected clay cover varying from 3 ft thick at the top to 10 ft at the base was also put on the river slope and a lighter cover on the back slope. This seemed necessary because of the large amount of sand that was mixed in with the material used for the bulk of the dike. Stone riprap wave protection was also added for a distance of nearly 4,000 lin ft at the most critical section, where the dike had a maximum height of 30 ft and a base width of 200 ft. This was carried from the top to above the high-water line, requiring 12,000 cu yd of one-man and two-man sized stone.

This structure was placed well back from the main low-water bank so that a broad foreshore was available for borrow pits. However, in early May, when the new dike was but half its full height, a sudden rise flooded the pits and we had to engage 300 small boats and bring much of the remaining earth a distance of nearly half a mile. The protective curtain dikes had proved inadequate but under the circumstances any larger expense for such protection was not warranted, since boat transport is cheap along China's rivers. One gang filled baskets at the new pits along the river and placed them in small rowboats. At the toe of the new dike each working gang had its associates to dump the baskets and pack the earth in place while the old man or woman at

the oars returned promptly to the pits. The costs of earthwork by this method were but little if any higher than by basket and carry-pole from the old pits when the haul was 300 ft or more.

In packing earthwork in place, a flat stone "flapper" is used. This implement, weighing from 80 to 100 lb, is thrown into the air by six or eight men standing around in a circle and each holding a short rope attached to the flapper. Good gangs toss it to a height of 8 ft and pull it down so that the lower face strikes the earth evenly with more force than that due to gravity alone. A square flapper is about 14 in. on a side by 5 in. thick. A round-faced one is much thicker, is cut like an hour glass for better rope attachment, and has about one square foot of striking surface. Two-man or three-man wooden tampers are sometimes used as emergency substitutes when the supply of stone flappers is inadequate. Earth in important dikes should not be piled in layers more than 18-in., and preferably not more than one foot thick before it is "flapped" or tamped twice. Clay soil is thus well compacted and voids of any consequence are prevented.

Finished Dike at Temple Hill
Yangtze on the Left

Good Saw-Tooth Kaoliang Groins
On the Yung Ting Ho, East of Peiping

This work at Temple Hill has stood the attacks of wind and current action for the past eight years without noticeable damage. The crops raised in the reclaimed land back of the structure the first year after it was built were estimated to have a total gross value of nearly $5,000,000 (Chinese currency). It was the first crop in seven years, and market prices were good.

DIKE PRACTICE ALONG THE YANGTZE

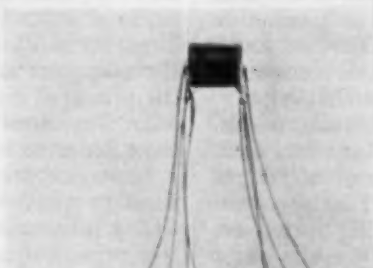
As a rule the river dragons have their way along the Yangtze, mountains of rock being about the only obstacle that they respect. Yet aside from the masonry bunding at the chief Yangtze port cities, stonework has played a very small part in bank protection along this river, nor are *kaoliang paks* used as on the Yellow River. Due to the heavy expense of stone groins and bank revetments in regions distant from suitable rock quarries, and a lack of sufficient public interest, it seems likely that the Yangtze Valley will continue for decades to depend on earth dikes that are altered in location to meet the whims of this great river.

The large rebuilding program of 1932 was one of reconstructing the old earth dikes and raising them to a height of one meter greater than that reached by the flood waters of August 1931. Practically no stonework was attempted in this connection. It was a huge dirt-moving job—about the only thing present-day China seems prepared to do.

While handling a part of this work assigned to the China International Famine Relief Commission, and also acting as consulting engineer to the National Flood Relief Commission, during the first half of 1932, I noted that too often earth dikes have been built along the Yangtze without adequate care in sections that have had frequent breaks and where large quantities of fine sand have been deposited in the breaches and near by. Frequently this sand has been used in rebuilding the main dikes with the result that serious breaks occur in such sections whenever extra high floods come. In the Kiukiang section it was found necessary to borrow as far away as half a mile in order to get suitable soil. Care in the use of trenches through sand to get good packed clay cores well below the ground surface, and thorough flapping of the new earth in 1-ft layers were found most efficacious.

Frail though they may seem, these earth dikes along the Yangtze after a year's settling and growth of sod are formidable against ordinary wash from flood waters, although few of them would last against a cutting river. New loops must be built to the rear when the river starts inland. The Yangtze must have some room for overflow when it reaches a stage that takes it out of its normal banks. If the earth dikes are set well back, a sufficient flood channel is afforded for all except the most extraordinary

Hand Tampers in Use on a Yangtze Dike in Spring of 1932



Where Hand Labor Is Cheap
An Expert Dike Gang Throwing an 80-Lb Flapping Stone

Driving a Pile with a Four-Man Stone Hammer on the Hsi Ho

occasions. As yet, however, the flood problem of the Yangtze has not been satisfactorily solved. No well informed engineer will say that it has even been thoroughly studied. Perhaps this recent flood disaster of 1931 will awaken new interest and some of China's ablest young engineers will make this problem their life work.

REBUILDING A YANGTZE DIKE IN ONE-FOOT LAYERS
This Heavy Section Was Entirely Washed Away by the 1931 Floods

STONE WALLS AND GROINS FOR DIKE PROTECTION
Along the Yellow River in Shantung

FLOODS ON THE YUNG TING HO

On the Yung Ting Ho, which leaves the western hills near Peiping and rushes under the old Marco Polo Bridge toward the great delta settling basin west of Tientsin, dike breaks are frequent in time of unusual floods. Ordinary sand-loess banks melt like sugar where not well protected by *kaoliang paks* tied back by ropes or pinned down by long piling, as is the custom on this river. Then, when a main dike is threatened, willow trees are cut and carried on the backs of 15 or 20 men to the danger point and thrown into the stream with their butts anchored to convenient stumps by rope or wire. These tree retards do good work in emergencies, for they retard velocities enough to cause deposition of silt and are a protection against erosion.

In this section, the Yung Ting Ho can discharge as much as 300,000 cu ft per sec for short periods, and its mud content is high—24 per cent of solids. Considerable stonework has been used to protect its banks in the area near and just east of Peiping. This is the only effective way to hold this river within its dikes. Farther south in this same province of Hopei heavy floods sometimes come down the various streams that cross the Peiping-Hankow Railway from the west. In 1924 these floods, following heavy July rains throughout the watershed, caused many dike breaks and produced a great lake of 7,000 sq miles in the Paotingfu-Peiping-Tientsin area.

In reconstructing the dikes the following spring we found that men in this region work willingly in the water when the weather is warm enough for them to go naked. Everything is hand work here as elsewhere in China. Two or three men with a small stone pile-driving hammer drive the short piles often used to protect dikes located close to running streams. Hundreds of men work in water 3 ft deep spading the stiff soil into cubes 8 in. on an edge and then ducking beneath the water to raise these chunks by hand into the waiting boats. Cargoes of such chunks are thus transferred a quarter of a mile or more to the dike and then passed by hand, chain-gang fashion, to their final position. Sturdy men working in all kinds of conditions handle North China's flood protection work, such as it is and has been for centuries.

HOLDING THE YELLOW RIVER BACK

Studies made in 1919 and 1920 under the direction of the late John R. Freeman, Hon. M. Am. Soc. C.E., taught several of us the use of stonework as applied by the Chinese to Yellow River control. Many miles of their stone walls and groins are most effective dike protection.

When the Saratsi irrigation work was undertaken in 1929 in Suiyuan Province, 450 miles northwest of Peiping by rail, I found no human efforts had been made in that part of China to prevent this river from meandering. Here conditions warranted the use of stone revetment only, without piling beneath as employed so often by the Chinese in Shantung. Nor did it seem wise to use the vertical type of wall that they prefer and have adopted for much of their Shantung work. On a carefully laid footing 2 ft thick and 5 ft wide, composed of large stones and placed just below extreme low water, bank protection of stone masonry was built up with a slope of 1 on $1^1/_2$ and carried 3 ft above flood-water marks.

This form of protection against erosion by current action was most effective, but in places where the channel threatened the foundation of our revetment work additional riprap was dumped in front of the toe, or long bamboo-frame "sausages" were shoved down into the channel in front of the masonry work.

RESPONSIBILITY FOR FLOOD CONTROL

Of the various modern river conservancy boards in China, few have been occupied with flood control as a major problem affecting the livelihood of the farming classes. Those that have been best financed have had to do with the improvement of navigation facilities at large ports. Old-fashioned provincial dike bureaus are the strongest organizations for dike maintenance along the principal rivers. Of these perhaps the Yellow River Dike Bureau of Shantung and the Hupeh River Bureau have done the most consistent work.

In recent years, much of the work of flood relief and flood prevention in China has fallen to the lot of the China International Famine Relief Commission, a volunteer organization, half foreign and half Chinese in make-up, which works with the various provinces concerned at their invitation, handles the work through its own engineers and expends funds contributed both by itself and by the provinces benefited. The American public has given strong financial support to this program for the past ten years and since 1928 has acted chiefly through the China Famine Relief, U.S.A., with offices in New York City.

With the very low rate of wages and the similarly low prices for native foods, when reduced to terms of foreign currencies, and with little likelihood of these wages or food prices being rapidly raised in the near future, it is incumbent on every civil engineer working in China to think in terms of human labor rather than of modern machinery when he prepares to carry out work in the back country. He must adapt his plans and construction program to the things available in China and of these the greatest is human labor—lots of it and of very good quality when in competent and experienced hands.

Pasadena Builds Pine Canyon Dam

Domestic Water Supply and Storage Project on the San Gabriel River

By Samuel B. Morris

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Like the early missions and settlements of southern California, the city of Pasadena was located by its founders on fertile lands adjoining perennial springs. Although these springs have long since ceased to flow, the rather large storage of ground water in the alluvial gravels and clays beneath the city has continued to serve it with 85 or 90 per cent of its supply. Ever since 1917 the draft has exceeded the average ground-water replenishment. Dry years and increasing demands for water from the growing city and its environs have caused an accelerated recession in ground water until at present it must be pumped from deep wells with an average lift of 308 ft. It has therefore become necessary to seek a water supply elsewhere. In this article Mr. Morris gives the pertinent facts concerning the Pine Canyon Dam now under construction to augment the city's supply.

In order to provide an adequate water supply for the growing City of Pasadena, applications were filed on March 27, 1923, with the State Division of Water Rights for a part of the flood waters of the San Gabriel River, 18 miles east of the city. On June 18, 1929, the citizens of Pasadena by a ten to one vote approved a \$10,000,000 bond issue for constructing the San Gabriel Water Supply Project.

Above the mouth of the canyon the San Gabriel River has a mountain drainage area of 214 sq miles. The Pine Canyon Dam, which derives its name from a tributary canyon, is being constructed in the main San Gabriel Canyon at a point about three miles above the canyon mouth, and will intercept the drainage from a total area of 209.6 sq miles. The name, Pine Canyon Dam, was adopted to distinguish this structure from the abandoned San Gabriel Dam and the San Gabriel dams Nos. 1 and 2 now under construction farther up the river by the Los Angeles County Flood Control District.

Elevations in the mountain drainage area vary from 930 ft at the dam site to the crest of the San Gabriel Range, from 6,000 to 10,000 ft above sea level. Precipitation occurs from November to April—there is little or none from May to October. The mean annual precipitation varies from 20 to 35 in.

Although the mean annual stream flow averages 115,000 acre-ft, the extremes of annual discharge vary from a record minimum of 9,600 acre-ft to a maximum of 410,000. Rates of stream flow vary from as little as 3 cu ft per sec to a maximum recorded discharge of 40,000 cu ft per sec in January 1916.

According to permits issued by the State Division of Water Resources on July 9, 1928, after a five-year hydrographic investigation, Pasadena is permitted to store not to exceed 65,000 acre-ft of water in any one year and to divert not more than 40,000 acre-ft in any one year, or an average in any five-year period of not to exceed 30,000 acre-ft per year, at a rate not exceeding 80 cu ft per sec. The city is required to release all normal stream flow already appropriated and to return to the ground-water basins below the mouth of the canyon all water that under natural conditions would percolate into the ground. The remainder, water that would actually have wasted to the sea, will be retained in storage and later diverted to Pasadena as required.

It is planned to use this San Gabriel water exclusively in wet and normal years, and in the dry years of the cycle, when no water is available from that source, to pump from the local ground-water basins, which will have been largely refilled during the wet and normal years when they were not drawn upon to any great extent.

The safe annual yield of the Pine Canyon Reservoir is estimated at 17,500 acre-ft. Including 11,500 acre-ft from local supplies, there will be a continuous flow of 26 million gal per day, sufficient water for 200,000 people consuming 130 gal per capita per day. The present population of Pasadena is 80,000, and that of the territory served by the Pasadena Water Department is 92,500.

After initiating the San Gabriel Project, including the construction of the Pine Canyon Dam, the City of Pasadena, which itself is a part of the Metropolitan Water District of Southern California, entered into a contract with the district on November 23, 1932, by the terms of which the district will purchase the Pine Canyon Dam and appurtenant works for use as a distribution reservoir for the storage and regulation of Colorado River water when that supply becomes available to Southern California on completion of the Colorado River Aqueduct. The only change in plan of the Pine Canyon Dam that was required to accommodate the larger release needed by the district was an increase in the size of the outlet tower and outlet pipes in the dam.

Geology of the Pine Canyon Dam Site

The San Gabriel Mountain Range is a great block of metamorphic and igneous rocks lying between two major fault zones, the San Andreas Rift on the north and the Sierra Madre Fault at the foot of the mountain range on the south. The Pine Canyon Dam is located in the narrowest part of the main San Gabriel Canyon, between the Sierra Madre and the San Gabriel faults, about two miles from the former and five miles from the latter.

At the dam site there are numerous insignificant faults, shear planes, and joints, but there is no evidence of recent movement. In fact, lack of displacement in the stratification of old stream-bed gravels establishes the fact that there has been no material motion in a period of about ten thousand years. One minor fault intersects the dam foundations near the base of the right abutment in a

direction nearly normal to the axis of the dam. Special provision for this has been made in the dam, including a joint along which motion can take place without hazard to the stability of the structure. The various joints and fractures in the foundation rock have been the subject of considerable "dental work" in the final excavation and concreting operations.

Probably more thorough preliminary exploration and testing were undertaken at this site than have ever been done for any other dam. This thoroughness was required by the general character of the rocks in the San Gabriel Mountains, by the large overburden of decomposed rock at the abutments, and by the deep gravel deposits in the stream bed. Exploration was done mainly by driving small tunnels and shafts, although 11 holes were cut by diamond core drill. Altogether there were 4,155 ft of exploration tunnels, shafts, and diamond core drilling in addition to the main outlet tunnel one-half mile long, driven into the right abutment. Some of the exploration tunnels will be left open permanently for drainage or inspection.

DESIGN OF PINE CANYON DAM

Consideration was given to all types of dam construction; in fact, several actual designs and estimates were made before a straight, gravity, concrete dam was finally adopted as the type best suited to the topographic and foundation conditions, giving proper consideration to economy. The general plan of the dam and spillway is shown in Fig. 1.

Concrete was assumed to weigh 150 lb per cu ft, but actually test specimens cut from the dam have weighed 155 lb per cu ft, and 14 by 28-in. compression cylinders made in the laboratory with full-sized aggregate have weighed from 157 to 158 lb per cu ft.

Uplift pressure was assumed to vary from 100 per cent of the head at the heel to 50 per cent at the line of drains just upstream from the galleries, thence diminishing uniformly to zero, or tailwater head, at the toe. These pressures are all considered as acting on 100 per cent of the area of the base of the structure. The foundations of the dam were grouted through a double line of grout holes in the deep cut-off trench, staggered 5 ft apart and 30 ft in depth. In addition, grout holes 150 ft deep were driven in the cut-off trench 25 ft on centers, but so far these deep holes have been found to take very little grout.

A monolithic concrete blanket, approximately 200 ft by 600 ft, varying in thickness from 8 in. at high water to 26 in. at the cut-off trench (Fig. 1), is provided to prevent percolation into the right abutment. This concrete blanket is fully underdrained into a gallery constructed in the cut-off trench and connecting by tunnel with the drainage galleries of the dam itself.

The dam has been designed to resist an earthquake shock with an acceleration one-tenth that of gravity. In addition to the inertia effect of a force one-tenth the mass of the dam, acting horizontally through the center of gravity of that part of the structure under consideration, there is the hydrodynamic effect due to oscillation of the dam against the still water in the reservoir.

The effect of the conservative assumptions of uplift and the inclusion of earthquake forces is shown by the adopted cross section of the dam, Fig. 2. In order better to fit the topography of the site, the abutment sections are curved to a radius of 716.3 ft. Consideration has been given to the effect of converging radii on the stability of the curved sections, which have therefore been made thicker than the straight ones. The upstream batter is the same as for the straight section, 0.05 to 1, but that on the downstream side is 0.875 to 1 above elevation 970 and 0.95 to 1 below it. Arch action was not considered, owing to the presence of the fault at the base of the right abutment.

Contraction joints are generally at 50-ft intervals, but have been adapted to fit topographic conditions. The narrowest block is 25 ft wide. The usual copper water seals in 8-in. wells, 2 ft 4 in. from the upstream face, are provided at the contraction joints.

In order to reduce the sliding factor at horizontal construction joints, the 5-ft lifts of concrete are placed on a 10 per cent grade, ascending in a downstream

FIG. 1. GENERAL PLAN OF PINE CANYON DAM AND SPILLWAY

direction. For 10 ft from the upstream face the grade is reversed so as to provide a clean-up trough 10 ft back from this face.

Six flood release outlets, with a combined maximum capacity of 6,000 cu ft per sec, are protected by one common trash-rack structure located on the upstream face of the dam and having a net area of 3,160 sq ft. The two lower outlets are 48-in. sluices at elevation 960 and are equipped with 48 by 36-in. needle valves at the downstream face of the dam. At elevation 975 there are two 96-in. outlets with 96 by 72-in. needle valves; one 54-in. outlet reduced to 48 in. below the venturi meter, with a 48 by 42-in. needle valve; and one 48-in. outlet with a 48 by 36-in. needle valve at the downstream face. The arrangement of the outlet pipes, needle valves, and emergency gates is shown in Figs. 1 and 2. The semicircular outlet tower, as redesigned in accordance with the agreement entered into with the Metropolitan Water District, is provided with eighteen 2 by 8-ft slide gates connected to $3^1/_2$-in. stems operated by hydraulic cylinders at the top of the dam. These gates are placed in pairs at intervals in elevation of 19 ft 3 in., with the sill of the lowest gate at an elevation of 1,000 ft. Semicircular, removable screens in approximately 10-ft sections will be lowered in front of the particular outlets in service.

A 9 by 9-ft slide gate, at the outlet in the base of the tower, affords emergency control over an outlet pipe 9 ft in diameter, which, until used by the Metropolitan District, terminates at the downstream face of the dam. Thence a 42-in. pipe will conduct the water to Pasadena.

SPILLWAY AUTOMATICALLY CONTROLLED

There are three spillway sections, of the overflow type, each equipped with floating, drum-type, welded structural-steel gates hinged downstream. Each gate is 70 ft long and 18 ft high and is controlled by floats, which automatically govern the release of water from the wells in which the gates float.

The lip of the spillway is at elevation 1,152 ft. When water rises in the reservoir above this elevation, the drum gates will rise until the water reaches the maximum storage level of 1,170 ft. At this elevation water will begin to flow over the tops of the gates, and they will drop approximately uniformly until they are completely depressed to the spillway lip, at elevation 1,152, when the water in the reservoir will have reached an elevation of 1,173 ft. At an elevation of 1,175 ft the spillway has a capacity of 80,000 cu ft-per sec, or twice the maximum recorded discharge. The gates may also be set by hand in any position desired.

One of the accompanying photographs shows a model of the spillway discharging the equivalent of the maximum recorded flood flow of 40,000 cu ft per sec. Much experimentation was done with models at various scales up to 1 in. = 4 ft before deciding on the final dimensions and proportions of the spillway. In order to provide for every possible combination of unequal drum-gate elevation and control, it was found necessary to continue the two walls between the spillway sections from the bridge piers down to elevation 1,014, that is, 138 ft below the spillway crest. By placing the drum gates on the chords of a circle concave downstream, the flow over the spillway is made to converge from 210 ft at the lip to 50 ft at the discharge end.

PANORAMA OF DOWNSTREAM FACE OF DAM AND SPILLWAY
Contractors' Plant and Progress of Construction on March 31, 1933

The floor of the spillway will be poured as a monolith directly on rock. It will have an average thickness of 2 ft and will be reinforced with hard-grade steel in both directions against temperature stresses. The concrete slab will be anchored into the rock by anchor bars 1 in. square on 8-ft centers. Weep holes $1^1/_2$ in. square on 8-ft centers will be provided.

Discharge over the spillway lip is calculated by the formula, $Q = CLH^{3/2}$. A value of 3.45 has been adopted for the coefficient C. The design finally chosen for the discharge end of the spillway chute is a cantilever structure substantially at stream-bed level, 800 ft downstream from the dam, and discharging upward at a gradient of 40 per cent.

On April 25, 1932, the contract for the construction of the dam was entered into by the City of Pasadena, requiring partial completion, so that water could be stored to spillway crest, by November 15, 1933 (under a penalty clause of $2,000 per day), and final completion by December 31, 1933. The contractors are Bent Brothers, Inc., of Los Angeles, the Winston Brothers Company, of Minneapolis, and William C. Crowell, of Pasadena. Their unit-price bid, based on the estimated quantities, totals $2,407,311.70.

All the rock and gravel and the equipment used in constructing the dam are furnished by the contractors, while the city furnishes the cement, the reinforcing steel, pipes, valves, and other material or equipment embodied in the structure and appurtenant works. The contract price for the mass concrete in the dam is $2.36 per cu yd; that for abutment excavation, $2.35 per cu yd; and that for spillway excavation, $2.07 per cu yd.

In undertaking the construction of a high, gravity-type, concrete dam containing 436,000 cu yd of mass concrete, in a total time of only 20 months from date of contract to date of final completion, much consideration was given to the limitation of internal heat in the mass concrete. Tests conducted by the Riverside Cement Company and also by the University of California for the Boulder Dam investigations, indicated that the ordinary commercial brands of cement locally available gave heats of hydration of 90 to 110 calories per gram in 28 days. After consultation and discussion, a specifica-

tion was prepared limiting the heat of hydration at seven days to 65 calories and that at 28 days to 80 calories per gram. This is believed to be the first time cement has been purchased under a specification limiting the heat of hydration during the setting of the concrete. Actually, the cement so far delivered or tested has in general shown a heat of hydration of 55 calories per gram at 7 days and 65 calories per gram at 28 days.

In place of tensile tests, 2 by 4-in. compression cylinders of one part of cement to three of standard Ottawa sand, having strengths of 800 lb at 7 days and 2,000 lb at 28 days, were specified, with the further provision that the 28-day tests should show strengths at least 50 per cent greater than the 7-day tests. Strengths of 1,200 to 2,000 lb at 7 days and 3,000 to 4,000 lb at 28 days are being obtained.

Delivery of cement is made in bulk by tank trucks and trailers hauling a net pay load of 21 tons direct from local mills to the dam site. By means of a hoist at the unloading station, one end of the tank is raised so that the cement flows out of the other end into a hopper, from which it is taken by screw-and-bucket conveyor to the top of a 4,000-bbl steel silo. From the silo it is pumped by means of a screw-type cement pump through a 5-in. steel pipe line 730 ft in length, with a rise of 302 ft, into a 700-bbl bin which is located directly over the concrete mixers.

CONCRETING PLANT

Aggregate in five sizes, from sand to 6-in. cobbles, is obtained by the contractors from a gravel pit two miles below the mouth of the canyon and is hauled two miles by standard-gage railroad to a reloading station at the mouth of the canyon, where it is stock-piled. An endless conveyor belt raises it into bins, from which it is drawn through manually controlled gates into the one-yard aerial tramway buckets. The aerial tramway is two miles in length and has a capacity of 225 cu yd per hr at 500 ft per min. It carries the aggregate to the concrete mixing plant at the top of the right abutment of the dam, where the buckets are automatically dumped into storage bins over the mixers.

The aggregate is drawn by gravity through manually controlled, air-operated gates into accumulative 4-yd weighing hoppers. Cement is automatically weighed in separate hoppers. Water is measured by automatic meters. The concrete is mixed in two 4-cu yd tilting mixers and automatically timed so that it will be 3 min in the mixers. It is then dumped on to 50-ft conveyor belts, which discharge it into straight-sided, bottom-dump buckets of 4-cu yd capacity. These buckets are placed in position by an industrial locomotive and flat car operating on a shuttle track.

Two $2^1/_2$-in., high-line cableways, 1,000 ft long, with one fixed head tower 100 ft high and two tail towers each rolling on separate four-rail tracks on the same roadbed, 400 ft in length, handle the placing of concrete in all parts of the dam. The cableways and buckets are electrically operated and manually controlled by "blind" hoistmen receiving instructions by electric signal or telephone from signal men located in a crow's nest in full view of all parts of the dam. The cable speed is 1,200 ft per min, so that the lifting and lowering speed with a four-part line is 300 ft per min. The tail towers operate at 150 ft per min by remote control in the hands of the hoistmen at the head tower. The two cableways are able to handle the buckets faster than the mixers can deliver the batches. The fastest time at which the

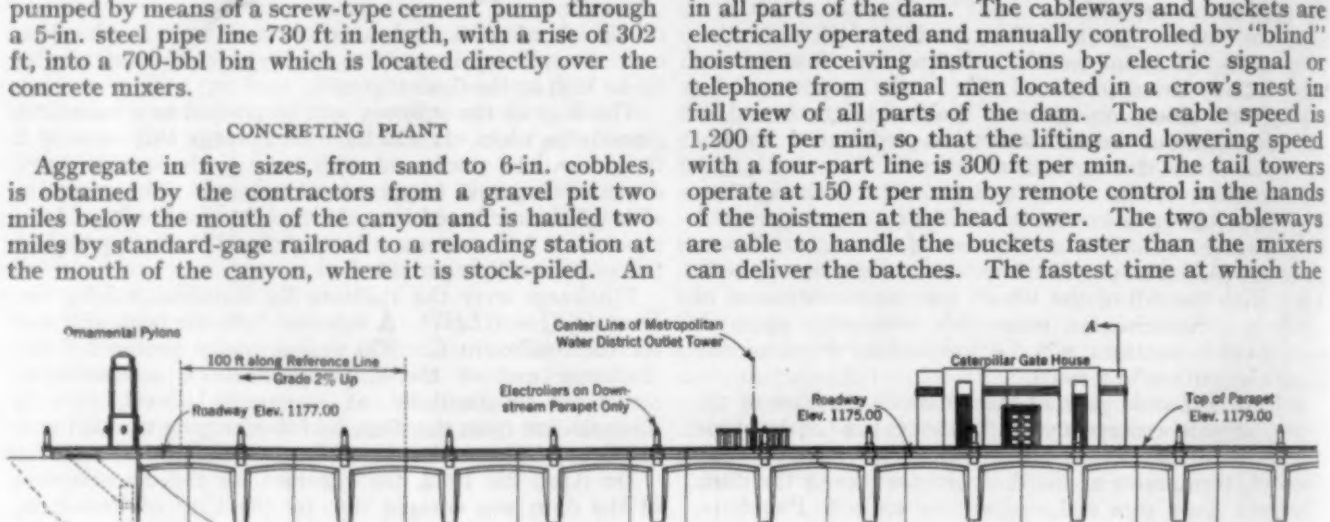


FIG. 2. DOWNSTREAM ELEVATION OF DAM

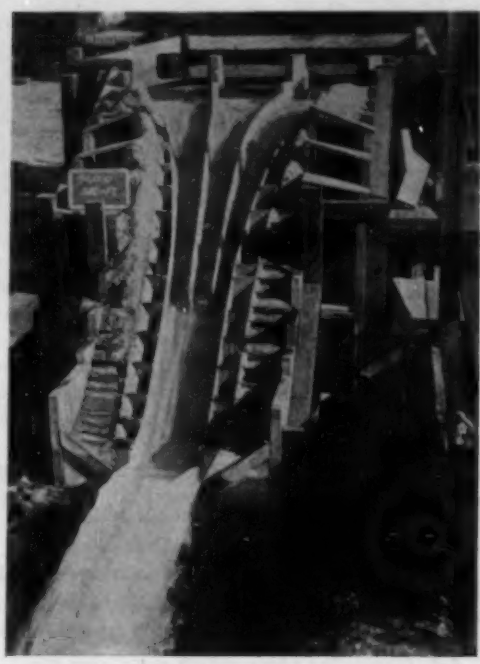
batches can be delivered is 3 min 20 sec per 4-cu yd batch from each of the two mixers.

The plant was designed to deliver 1,500 cu yd of concrete in two 8-hr shifts. The best record has been slightly over 2,000 cu yd in two shifts. Buckets of concrete are not dumped until they are within 2 ft or less of the concrete surface. The operation of the buckets has been perfected so that they are self-closing.

All mass concrete is placed by means of both internal and external electrical vibrators. In general, a concrete placing crew consists of eight men, including the foreman. Very little shoveling of concrete is required except next to the forms. Three internal vibrators operated by one man each, and one external platform vibrator operated by two men, are generally employed in placing concrete that has a slump of less than 1 in.

Vigorous wire-brushing is given the surface of the concrete within six to eight hours after placing to remove what little laitance there is and to give more effective bond. Grout is brushed into the surface of all old concrete just prior to the placing of fresh concrete.

Very rigid control of the concrete is maintained, and it is continuously checked by laboratory tests. The weights of the cement and all aggregates and the setting of the water meter are determined and fixed by the inspector at the mixing plant. Tests of moisture in sand and pea gravel are made at about 20-min intervals, and curves are plotted to show trends in moisture content, for which adjustment is made in the water meter. Twice in each shift samples of concrete are taken, from which are made one 14 by 28-in. cylinder, with full-sized aggregate, and two 6 by 12-in. cylinders with aggregate from which all material coarser than $1^1/_2$ in. has been removed by screening. In the main body of the dam, 0.95 bbl of cement per cu yd and a water-cement ratio of 1.68 are used. About 25 per cent of the aggregate is cobble size. For 10 ft at the upstream face of the dam, the concrete contains 1.10 bbl of cement per cubic yard and has a cement-water ratio of 1.85 to give a more impervious concrete.



Model of Spillway Discharging the Equivalent of 40,000 Cu Ft per Sec

One-Half the Rated Capacity of the Prototype

At the dam site there is a complete concrete testing laboratory where all physical testing of concrete and cement is carried out. A 600,000-lb testing machine makes possible the use of 14 by 28-in. cylinders with full-sized aggregate. The strengths attained with this aggregate are about 20 per cent less than those for 6 by 12-in. cylinders from which all aggregate over $1^1/_2$ in. has been screened out.

According to present estimates, the cost of the San Gabriel Project will be as follows:

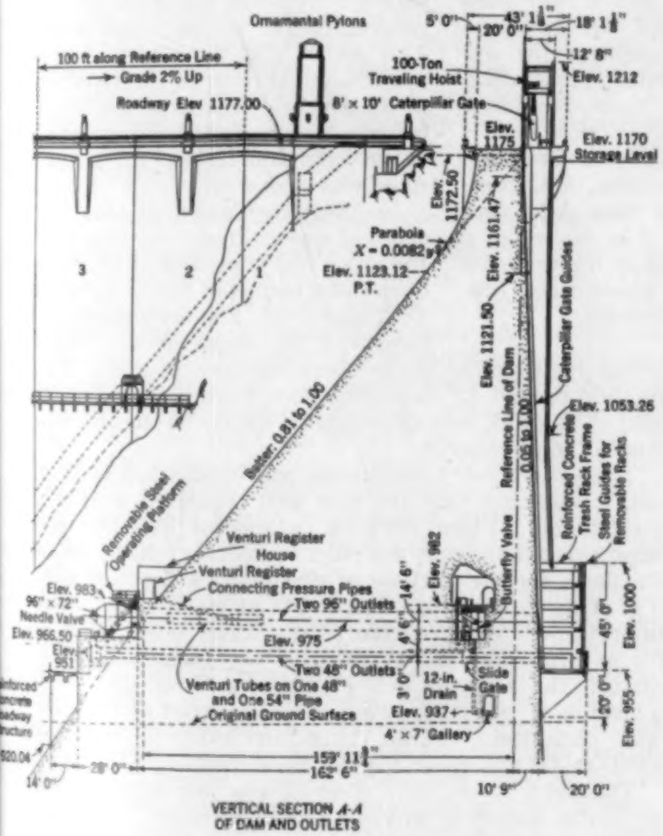
General expenses, including hydrographic investigations, water rights, legal and financial expenses	$225,300
Reservoir charges, including surveys, lands, Azusa Hydro-Electric Plant, roads, clearing, and sanitation	1,762,000
Dam—design and construction	4,214,900
Conduit to Pasadena	1,320,000
Grand total	$7,522,200

These estimates do not include interest during construction or the additional cost of $50,000 for enlarging the outlet tower to provide for the later needs of the Metropolitan Water District.

PERSONNEL

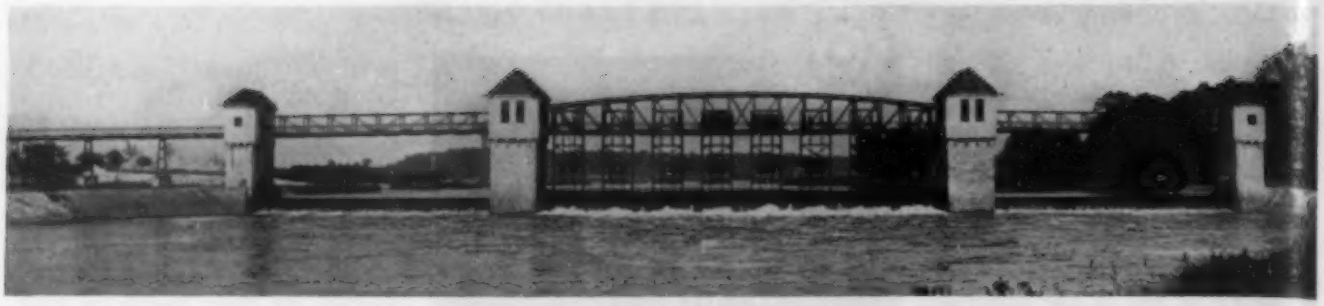
The San Gabriel Project, including the design and construction of the Pine Canyon Dam, is under my immediate charge. The consulting engineers are: Louis C. Hill, Fred A. Noetzli, and A. L. Sonderegger, Members Am. Soc. C.E.; and Dr. Frederick L. Ransome is the consulting geologist. Claude W. Sopp, Assoc. M. Am. Soc. C.E., is responsible for the hydrographic studies; Cecil E. Pearce, Assoc. M. Am. Soc. C.E., is the Designing Engineer; Ross White, M. Am. Soc. C.E., the Construction Engineer; and Verne L. Peugh, Assoc. M. Am. Soc. C.E., the Resident Engineer.

H. Stanley Bent is General Manager for the contractors, Bent Brothers, Inc., the Winston Brothers Company, and William C. Crowell. The General Superintendent is L. T. Grider and the Assistant Superintendent is E. W. Whipple.



Six Flood Release Outlets Provided

and Section Through Outlets



Lock and Dam on Oder River at Ransern, Below Breslau, Germany
Lift Gates in Center Section Can Be Swung Clear to Provide Unobstructed Pathway for Shipping

Improving the Oder River

A Review of Man's Efforts to Control One of Germany's Most Interesting Inland Waterways

By John B. Drisko
Junior, American Society of Civil Engineers
Instructor, Civil Engineering Department, Massachusetts Institute of Technology, Cambridge, Mass.

Before the time of Frederick the Great, the Oder was a wild and untamed stream wandering at will over a valley floor covered by a dense oak forest. The frequent dams that had been built previously served merely to prevent communication between feudal domains and to retard run-off in time of flood. Since the early eighteenth century, the river has been shortened by cut-offs; its alignment has been improved; the upper section has been canalized; the channel has been stabilized; storage to augment the low flows has been provided; and dikes have been built for flood protection. The improvements here described by Mr. Drisko have made large-scale navigation both possible and profitable, have benefited agriculture, and have held back the recurrent floods. The history of a river, covering a period of two centuries of almost continuous development, cannot fail to appeal to engineers.

One of the most striking parts of the tremendous inland waterway system which Germany has developed within her borders is the Oder River. With its problems of flood control and its large freight traffic, it receives a fair share of the yearly appropriations of millions of marks which are spent on the many navigable rivers and their connecting canals. This river has undergone a long period of development from glacial times to the present, and a study of its formation and growth helps to explain some of its peculiarities.

As the ice layer that covered Northern Europe retreated, the water collected along its southern edge in long channels, or valleys, and flowed westward into the North Sea. The Oder, after leaving its source high in the Moravian Mountains, flows northwest across upper Silesia and then flows a short distance west in each of these four original valleys, cutting through from valley to valley in a northerly direction (Fig. 1). This accounts for its zigzag course and for the irregularities of its slope and the configuration of the valley floor.

The valley floor was a dense oak forest, in which the river followed the freest course, and there is hardly a part of the valley which was not at one time in the path of the river. Oak trunks are still taken from the bed every year—trunks buried perhaps hundreds of years ago. Up to the time of Frederick the Great, in the middle eighteenth century, this wild condition of the river was aggravated rather than helped. Frequent dams hindered run-off in time of flood and prevented navigation. These dams were sometimes built for power, but more often to separate rival domains and prevent commerce between them. By bringing about political unification, Frederick removed the excuse for the dams. He also helped agriculture in the low flood plain by straightening the river and taking out countless tree trunks. This facilitated quick run-off of flood waters and dried up swampy regions, thus making more land available. During the time of Frederick the river was considerably shortened, chiefly by cut-offs, so that an original stretch of 496 miles was reduced to 400 miles.

About 1750, in order to drain some 260 sq miles of low land in the wide section of the valley below the mouth of the Warte, a side canal was excavated, parallel to the general course of the main river. This canal (Fig. 1), which is now the straight section of the river immediately below Cüstrin, gradually became larger until it carried most of the water, and in 1832 the original river was closed off.

In 1841, regulation of the river channel was started. At that time the river bed consisted of alternate deep holes and sand bars. Between 1841 and 1848, a short stretch was improved by means of wing dams projecting from the banks to contract the channel. This method proved so successful that, beginning in 1859, a sum of $215,000 was appropriated yearly to continue the work of improvement.

The Oder River Commission was established in 1874, and it was then that the first well organized work was undertaken. From 1879 on, a sum of $270,000 was appropriated annually for river correction (chiefly below Breslau), for the purpose of producing a depth of over 3 ft at mean low stage and $6^1/_2$ ft at mean stage. This improvement did not change the water levels, that is, for a given flow the stage after the improvement remained the same as before. Between 1890 and 1922, a stretch of 100 miles along the upper part of the river was canalized. From 1816 to 1913, a total of $18,000,000 was spent for the development of the river.

The Oder is the only river of any size whose entire navigable length is within German territory. Its total length is 535 miles, of which the 409-mile stretch from Cosel to the Stettiner Haff is navigable for boats drawing 4 ft, except at extreme low water. The width at ordinary

stages varies from 250 ft at the head of navigation to 425 ft at the mouth of the Warte, its principal tributary. The Warte has a drainage area of 20,750 sq miles, nearly the equal of the 20,900 sq miles which drain into the Oder itself above Cüstrin, where the two rivers meet. An additional area of 4,180 sq miles below the confluence gives the Oder a total drainage area of 45,830 sq miles.

The fall in the navigable Oder is variable. In the upper canalized section the bed slope is about 0.00035 or 1.8 ft per mile. Immediately below the canalization the bed has been deeply eroded and the surface slope is comparatively small—0.00019 or 1.0 ft per mile. Downstream, the surface slope varies, reaching a maximum of 0.00030, or nearly 1.6 ft per mile. Thus the average fall below the canalization is 0.00028, or 1.5 ft per mile.

The mean velocity of the stream varies from 2 ft per sec at low stage to 5 or 6 ft per sec at flood stage. At Breslau, the average discharge is 5,270 cu ft per sec, and the maximum recorded flood discharge is 84,700 cu ft per sec.

Below the confluence with the Warte, the Oder has a large flow of water, and its improvement offers no technical difficulties. Since the valley floor is very low, the floods do not run off quickly. The slope in this region is flat and the current is not strong enough to transport the sand brought from above. Dredging is the only remedy here; the more thoroughly it is done, the better the erosive power is maintained.

In three places along the river (Fig. 1)—at Cosel, at Ransern, and again at Fürstenberg—the river bed is being lowered by erosion. At Cosel, which is the upper end of the navigable river, and at Fürstenberg, where the Oder-Spree Canal enters, the large numbers of barges have an effect similar to an ice covering and aggravate bed scour. Also, anchoring and poling of the barges loosens the bed materials and promotes erosion. At Ransern, just below the last lock and dam of the canalized stretch, the bed is being washed away because there is a lack of sand from above to replace that carried away by the river.

NAVIGATION IMPORTANT CONSIDERATION

Navigation on the upper river is essential in order to enable Silesian coal to compete with other coals. Toward the latter part of the nineteenth century, the size of the barges used there had considerably increased. These larger barges required a greater depth, and it was for this reason that the upper river was canalized. The size of the barges is still slowly increasing. In 1925 there were on the Oder about 1,900 barges, most of them of 400-ton capacity. About 100 were of 600-ton capacity (a size which is increasing in popularity), and there were a few 210-ft barges, with a capacity of 780 tons. At present there is talk of using 1,000-ton barges.

The barges are usually permitted to drift or sail downstream and are towed upstream, the usual tow consisting of from 8 to 14 barges, arranged in two rows. The tugs, which draw from $2^1/_2$ to 4 ft, are of various sorts. Stern-wheel boats are preferred, as they are easier to handle and less expensive to run than propeller-driven boats. Side wheelers are also widely used. To permit passage under low bridges, funnels can be tilted and other superstructure removed if necessary. Express boats, for perishable goods, are large individually powered steel barges having a draft of from 4 to 6 ft.

A total of over 4 million tons of freight is transported yearly on the Oder. The chief commodities carried are coal, coke, and ores. Coal and coke are taken downstream from Silesia to Stettin, Berlin, and to the Elbe harbors, such as Hamburg. Ore is taken from sea-

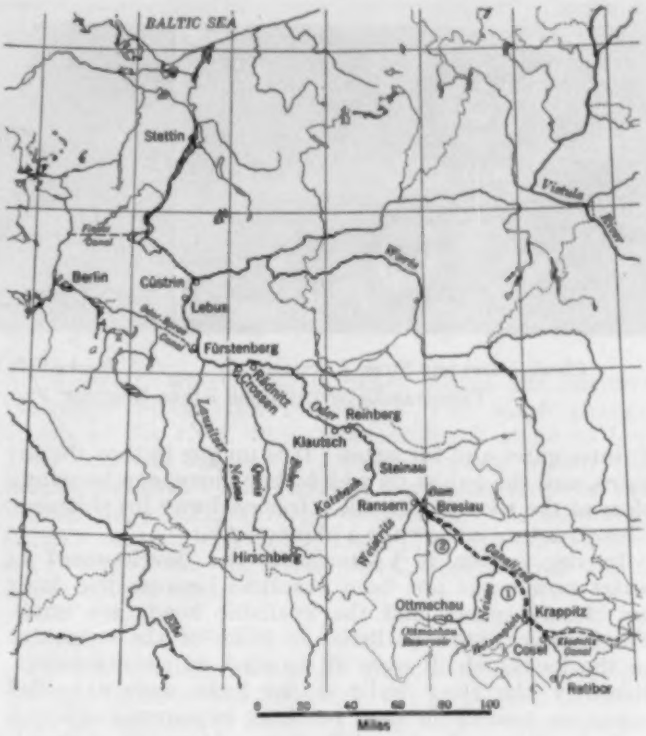


FIG. 1. THE ODER RIVER AND TRIBUTARIES, GERMANY

going vessels at Stettin and carried up the Oder to the Silesian industries. Both coal and ores must be carried by rail between the mines and Cosel. At present it costs only about twice as much to carry a ton of coal 400 miles from Cosel to Berlin by water as it does to carry it 35 miles by rail from the mines to Cosel; that is, one-third the total charge is for about one-twelfth the distance. There are two plans for remedying this situation. One calls for the construction of a private railroad to be used exclusively for transporting coal and ores to and from Cosel. The second is to enlarge the Klodnitz Canal, which joins Cosel with the mining district. This canal can now accommodate only very small boats.

CANALIZATION OF THE ODER

Between 1890 and 1897, the 50-mile stretch of the Oder from Cosel to the mouth of the Neisse was provided with 12 movable dams. In the first decade of the present century the canalization was continued to Breslau, and in 1922 one more dam and lock below Breslau was completed, making a total canalized length of 100 miles, with a depth of 5 ft at all times.

The locks have a clear entrance width of 31.5 ft and a length of 590 ft. The last lock, below Breslau, has an entrance width of 39.4 ft and a length of 640 ft. With one exception all the 22 dams are needle dams, which are cheap to build but expensive to operate. They have wooden needles, with the lower ends set against a sill on the river bed and the upper ends supported by a row of collapsible trestles, which, when folded, lie flush with the river bed. They leave a free course for the floods when drawn but produce great irregularities in the flow, since they must be drawn at a rising stage and cannot be replaced until the water has dropped to a low stage.

This tends to accentuate the large flows, which should be detained, and to rob the low flows, which should be augmented.

The last dam and lock, at Ransern, just below Breslau, was completed in 1922. The movable part is made up of Tainter gates and lift gates. It is unique in that the lift gates, and the guides on which they move, can be swung clear of the river to provide a free pathway for shipping. This structure is shown in a photograph.

Check Dams and Stone Revetment

Rocks Left by Floods on Bober River

TRIBUTARIES OF THE ODER RIVER REQUIRE PROTECTIVE WORKS

In the section first canalized, the development of water power has not been practical because the dams are closely spaced and the available heads are small. Furthermore, sand gathered in front of the entrances to the locks, which were all located on convex banks. Recently the river walls of the locks were extended upstream toward the next bend, an improvement which entirely removed this difficulty. Along the stretch canalized later, the dams are more favorably located. Water power is developed at three of them, and none of the locks is troubled with sand deposits.

The first canalization, from Cosel to the mouth of the Neisse, was needed to provide sufficient depth for navigation, but the second (1900–1910) was perhaps unnecessary. With proper regulation, the added flow of the Neisse probably would have provided a satisfactory depth at considerably less cost. The 50 miles of canalization cost over $8,100,000, while open river regulation would have cost about half this sum. Maintenance is also considerably greater for the canalized stretch than for the open river, costing $3,830 per mile annually as against $1,260 per mile for open river regulation.

ADVERSE EFFECTS OF CANALIZATION

While the canalization has of course provided a sufficient depth for navigation, it has also had adverse effects on the regimen of the river. The three most outstanding of these effects are: (1) a rise of from 3 to 6 ft in the ground-water level in the valley floor, making much of the land too wet for farming; (2) a lowering of the river flow due to increased evaporation as a result of the higher ground-water level; and (3) erosion of the river bed immediately below the canalized stretch, since the pools above act as settling basins to prevent sand from moving along to take the place of that washed away. This erosion of the bed lowered the water level so as to leave an insufficient depth over the sill of the lock at Breslau and expose pile foundations and bulwarks, which began to weaken and collapse. These conditions led to the construction of the last dam and lock at Ransern in the years 1915–1922.

The erosion of the river bed that is now occurring below this new lock and dam is so serious that the commission is contemplating protecting five miles of river bed with a layer of stone. In 1928, at a cost of $21,400, an experimental stretch was protected, and it will be observed before further work is done. Two methods were tried. The first is a continuous covering of broken stone, 8 in. thick, over the full 160-ft width of the river bed, and 790 ft long. The second, used immediately below this solid layer, consists of five sills across the river. The sills are 33 ft wide (in the direction of flow) and were built to the desired level of the river bed. The first is 200 ft downstream from the solid protection, the second 246 ft below the first, and the succeeding three at intervals of 82 ft.

Stone was placed by two methods. In the first, broken stone was shoveled into two vertical tubes that delivered the stone piles on the bottom. Men working in a diving bell leveled the piles and distributed the stone evenly. This method proved both slow and expensive, so an improved rig was built to accelerate the work. A honeycomb of closely placed vertical tubes reaching to the bottom was supported from a scow. A stone barge was brought alongside and laborers shoveled a definite amount of stone into each cell of the honeycomb. The whole rig was then moved along and the process repeated. The finished work was examined with a diving bell and found satisfactory. Water depths during this work varied from 3 to 5 ft.

REGULATION BY MEANS OF GROINS

Among the chief requirements for river navigation are a uniform, unobstructed channel of sufficient depth, and freedom from sharp bends. On the Oder, a uniform channel has been obtained largely by means of groins, or wing dams. The river is first confined to one channel and then groins are built out from the banks wherever necessary to narrow the stream to the desired width. The groin heads fall on an imaginary line, which is the bank line of the ultimate channel and which may be called the "channel line." The "width" of the river is the width between these channel lines, and the cross section used in calculations is the section taken between two opposing groin heads.

The groins are placed at an angle of about 75 deg to the direction of flow, pointing slightly upstream, with their tops 4 in. higher than the ordinary river stage. There are many reasons for their oblique position. If they pointed downstream, the water spilling over them, when submerged, would flow toward the banks. With the groins pointing upstream, the river bed has fewer deep holes and irregularities, more material is deposited between the groins, and less wandering detritus is left in the river. During floods, great quantities of sand are often deposited between the groins.

While the second canalization was still in progress, some practical research was undertaken (1906–1910) in order to secure better open river regulation. As an experiment, three test sections were improved, each 6.2 miles long and each having slightly different training works. The first section was improved with the usual groins and was the most satisfactory. For the second section, the training works were groins with low submerged longitudinal dikes running lengthwise between

the groin heads. Although this arrangement caused greater deposits between the groins, it was expensive, often troublesome for navigation, and rendered costly any subsequent widening or narrowing of the river that might be required. The third test section, with groins having very flat heads—1 on 15 and 1 on 20—gave insufficient depths.

Because these tests showed that great improvement in the river flow was possible, a thorough re-regulation of the river was authorized in 1913, but the actual work was not started until 1924. By the end of 1930 about one-third of the proposed improvement was completed.

The project provides for the improvement of the 205-mile stretch extending downstream from Ransern to Lebus, with the ultimate aim a minimum depth of 4.6 ft. The training works which existed before the project was formulated were neither uniform nor satisfactory, since the course of the river was poor. The groins were frequently too high, and the groin heads very steep. Low extensions had been built on some of them to reduce the steepness, but these proved to be of questionable value and hindered navigation.

Under the new project, all the groin heads have smooth and uniform slopes varying from 1 on 5 up river, to 1 on 10 at the mouth of the Warte. Groins are placed opposite each other, since they are not as effective when staggered. New groins have no brush work above mean low stage, as this deteriorates rapidly when exposed alternately to air and water. A photograph illustrates a recently completed groin. In many places sharp curves are being flattened, necessitating shortening of the old groins on one side and lengthening of those on the other.

TREATMENT OF ENTERING TRIBUTARIES TO PREVENT DEPOSITS AT THEIR MOUTHS

The entrance of tributaries is a bothersome problem on the Oder. The tributaries from the western side, those flowing from the Silesian Mountains, are steeper than the Oder and bring in coarse sand, which tends to deposit as a delta at their mouths. They are therefore brought into the main river on the outside of a curve whenever possible. In order to ensure smooth flow and sufficient contraction to promote erosion, the banks of both Oder and tributary are usually filled out to the ultimate channel line for a short distance above and below the entrance, and the width of the Oder is kept constant for several hundred yards below the point of junction. In spite of these precautions, however, sand bars and deep holes still form at the mouths of the tributaries.

The construction of new groins, the rebuilding of the old ones, the filling of the groin spaces on the concave shores of the sharper curves, the flattening of the sharper curves, and the construction of various cut-offs, are items in the general program of improving the Oder, both for navigation and for flood protection. The estimated cost of improvement for the entire 205 miles is $14,000,000. At the end of 1930, over $4,650,000 had been expended on the worst sections, totaling 68 miles. The commission does not like to undertake too much in wet years as the high stages prevent careful work around the base of the groins, which is necessary to ensure against undercutting.

In laying out the course of the river and placing the groins, much attention has been given to the problem of adapting the river channel to various flow conditions. It is quite as essential to utilize the low flows to the best advantage as it is to handle the high flows with a minimum of trouble. The flood course of a river is usually quite direct, whereas at ordinary stages the channel meanders within the floodway. The same change occurs as the river drops from ordinary stage to low flow, and the low-water stream wanders within the normal channel. The vigorous sand movement in the bed of the river at present shows that the allowable limit of contraction has been reached. Further narrowing would make the river unmanageable and would increase flood stages.

A Recently Completed Groin

Constructing the Cut-Off at Reinberg

Improvements on the Oder River

GROINS AT RIVER BENDS

In the symmetrical cross sections which occur at points of channel contraflexure, the groin ends on both sides of the channel have the same slope. As the river enters a sharp curve, the ends of the groins on the outer or concave bank are made steeper, and those on the convex bank correspondingly flatter. By thus varying the shape of the channel and its alignment a smoother river bed, with less pronounced bars and deeps, is obtained.

Sharp bends in the river make navigation difficult and also favor the formation of sand bars. Wherever possible, the radius of curvature of the channel is made at least six to eight times the channel width. The project calls for a minimum radius of 1,300 ft, except in extraordinary cases.

Sharp curves may be flattened somewhat by changing the groins along the banks. The most abrupt bends, however, require the construction of a cut-off. Each new cut-off increases the slope of the river slightly, and since the Oder already has a slope of 1.5 ft per mile, numerous cut-offs are not advisable. In some places, however, a cut-off is the only solution.

THE CUT-OFF AT REINBERG

At Reinberg the river was given a smooth curving channel across the neck of the bend, since straight stretches are not considered advisable for distances longer than about three times the river width, and then only between curves of opposite sense. The cut-off, shown in Fig. 2, has a minimum radius of 1,800 ft, compared with 1,000 ft for the original bend. It is $1^1/_4$ miles long and shortened the river one-third mile. The original cross section of the cut-off at its mid-point was almost triangular, as may also be seen from Fig. 2. The cut-off was excavated to its final dimensions and completely reveted before the river was allowed to flow through it.

The cross section of the cut-off has held fairly well. Although the flood of 1930 eroded the bed severely, its

transverse slope was little changed, being 1:33 after the flood. The lower part of the convex bank was also eroded.

Experience gained from previous cut-offs indicates the following requirements for the double cut-off now under construction at Klautsch: a concave bank slope of 1:3, a convex bank slope of 1:10, and a transverse

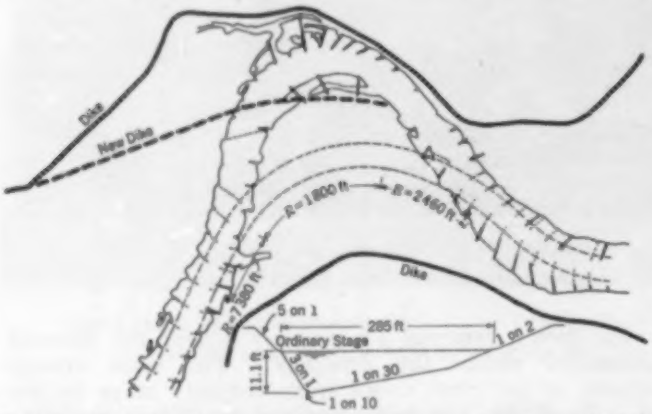


FIG. 2. THE CUT-OFF ON THE ODER RIVER AT REINBERG (1928) Cross Section Shown in Insert

bed slope of 1:46. The mean radius of the curve will be 2,880 ft.

The cut-off made at Reinberg in 1928 delayed traffic but a few hours. The boats used the old river until the cut-off was ready to be opened; then the old river was partially dammed, the low dam across the upper end of the cut-off was removed, and the closing of the old river was finished. There was a very low flow at the time of the opening.

STORAGE PROVIDED AT OTTMACHAU RESERVOIR

Open river regulation below Breslau will provide a minimum depth of 4.3 ft during all but the driest times. Additional flow from storage will increase this depth to 4.6 ft. A reservoir to provide this extra water is now being completed at Ottmachau and was put in operation in the spring of 1933. A part of the capacity is reserved for flood storage on the Neisse. This reservoir will also practically double the output of the power stations on the Oder above Breslau by maintaining a larger and more uniform flow. Pertinent data regarding this reservoir are shown in Table I.

TABLE I. DATA ON OTTMACHAU STORAGE RESERVOIR

Normal storage for low-flow increase	77,100 acre-ft
Flood storage	35,100 acre-ft
Total storage	116,000 acre-ft
Surface area, with normal head	4,650 acres
Surface area, with maximum head	5,440 acres
Drainage area	907 sq miles
Average yearly rainfall over drainage area	$23^1/_2$–$27^1/_2$ in.
Estimated cost	$13,100,000
Total length of earth dams	3.7 miles
Maximum height of earth dams	56 ft

The yearly flow into the reservoir is over eight times its normal capacity, so that it should be filled every year. A power plant below the reservoir will utilize all possible flow, and an output of 14,000,000 kwhr per year is expected. An equalizing basin covering 99 acres will be provided just below the reservoir to smooth out the irregularities of flow which correspond to the demand on the power plant. From this basin the water flows 43 miles in the Neisse to the Oder and then 50 miles in the canalized Oder before it reaches the section where it is needed. An average additional flow of 247 cu ft per sec will be required in the open river to provide a depth of 4.6 ft, and it is expected that an extra 106 cu ft per sec from the reservoir will be necessary to allow for the irregularities in operation of the dams and power plants on the canalized Oder.

FLOOD CONTROL ON THE ODER

The history of flood control on the Oder has been a long one. From the earliest times, protection against high water has been a serious problem. Although the dikes along the river date back to the twelfth century, the first systematic work came as a result of the dike law of 1848. Since that time the work of strengthening and rebuilding the dikes has gone on continuously.

The standard dike of today has a water-side slope of 1 on 3, a top width of 11.5 ft, a land-side slope of 1 on 2, and a berm 13.2 ft wide and 6.2 below the top of the dike. The dikes have a freeboard of 3.3 ft above the maximum recorded flood level. Although all the dikes have not been brought to these standard dimensions, the weaker sections are being strengthened as fast as circumstances permit. The area of land protected by the dikes is about 967 sq miles.

The floodway between the dikes has been improved from time to time by removing constrictions, since it is quite as important to have a good floodway as it is to have strong dikes. To prevent weakening of the dikes certain rules are observed on the land side. Land within 3 ft of a dike may not be plowed; no house foundations may be placed within 65 ft of a dike; and no ditches may be dug within 250 ft.

The floods of the Oder are rain floods; melting snow has a relatively small effect. The maximum discharge increases very little below Breslau and in some stretches even decreases. This is due to the natural flood reservoirs, such as wide foreshores and ground-water storage, and to the fact that the floods on the main river and on all the tributaries do not synchronize. Even the ordinary flow of the Oder does not increase in proportion to the area drained; only the low flow shows a correspondence with the contributory area.

Floods are also somewhat mitigated by storage in so-called overflow meadows—low-lying regions in the river valley which receive flood water at the higher flood stages. There are ten of these meadows along the Oder having a total capacity of 55,000 acre-ft.

At Breslau, where the river divides, subdivides, and reunites in various ways, the city is protected by a combination of by-passes and overflow meadows.

FLOOD CONTROL ON THE TRIBUTARIES OF THE ODER

The tributaries of the Oder, and in particular those coming from the Silesian Mountains, present a serious flood problem. Their upper sections are steep mountain torrents which can swell in a few hours to havoc-raising proportions. In order to check erosion of the valley floor, frequent log or stone check dams of low height are built. Material is retained above these check dams, thus giving a wider, flatter valley floor, which lessens the likelihood of land slips.

Besides the check dams, there are numerous flood detention reservoirs on the larger streams. Some of these are used for power development in connection with flood storage, but the larger number are purely for flood relief.

Plans for connecting the Oder with the Elbe and the Danube by large canals have been outlined, and indicate the intense interest in inland waterway transportation that exists in Germany.

Translatory Waves in Open Channels

Theoretical Analysis of Movement Caused by Changing the Depth of Water

By Horace W. King

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ENGINEERS who design open channels for conducting water are faced with the problem of providing the proper freeboard for the many types of waves and surges that form in such structures. Some of these waves are stationary and others are of the traveling type. In this article Professor King develops the hydraulic theory of the abrupt moving wave, which forms when a change in discharge increases the depth of the channel, and that of the wave with a sloping face, which forms when the channel depth is decreased. A number of formulas for practical application are given. Considerable engineering interest attaches to the various types of waves that form in open channels, some of which are little understood.

WHEN water is flowing in an open channel under conditions of steady flow, if the discharge at the intake is suddenly increased, an abrupt wave of acceleration (Fig. 1) travels down the channel. If the discharge at the outlet is suddenly decreased, an abrupt wave of deceleration (Fig. 2) travels up the channel. Similarly, a sudden decrease in discharge at the intake causes a sloping wave of deceleration (Fig. 4) to travel down the channel, and a sudden increase in discharge at the outlet causes a sloping wave of acceleration to travel up the channel.

Of waves of translation in general it may be said that an accelerating wave (positive or negative) forms in a channel whenever the discharge is suddenly changed. If the change acts to increase the depth, the wave has an abrupt face, and if it acts to decrease the depth the wave has a sloping face. The hydraulic jump is a special case of the abrupt wave of translation.

If the discharge into a channel of rectangular cross section is suddenly increased, conditions at the end of one second will be as shown in Fig. 1. The gate, G, is assumed to be raised instantaneously, thereby increasing the discharge per foot of channel width from Q_1 to Q_2. This causes an abrupt wave of acceleration to travel down the channel. Between the wave and the gate each section has the same depth, D_2, and the same velocity, V_2, neglecting the modifying effects of friction and channel slope. Downstream from the wave, the depth D_1 and the velocity V_1 remain the same as before the additional water was admitted.

The wave, which travels with a velocity v_w, is at a distance v_w below the gate at the end of one second. The total volume of water that entered the channel during this second is $Q_2 = D_2V_2$, represented in the diagram, Fig. 1, by the area *abcd*. The increase in volume over that which would have passed through the gate in its

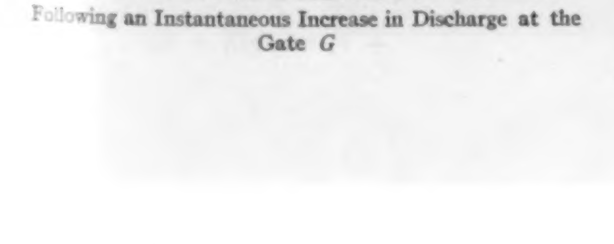

Fig. 1. Abrupt Wave Traveling Downstream Following an Instantaneous Increase in Discharge at the Gate G

original position, or $Q_2 - Q_1$, is represented by the area *aefg*. Expressed algebraically,

$$Q_2 - Q_1 = v_w\,(D_2 - D_1) \quad . \; . \; . \; . \; . \; . \; [1]$$

or, substituting V_2D_2 and V_1D_1 for Q_2 and Q_1, respectively, and transposing,

$$V_2 = (D_1V_1 + D_2v_w - D_1v_w)\,\frac{1}{D_2} \quad . \; . \; . \; [2]$$

The mass of water per foot of channel width represented by *dchg* has had its velocity increased from V_1 to V_2, and its momentum has thereby been increased.

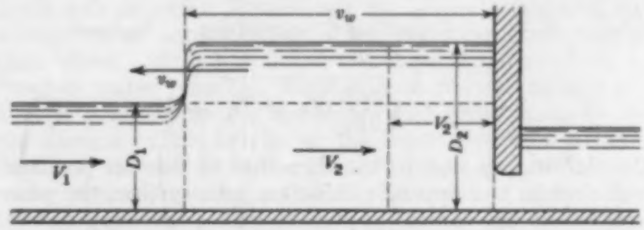

Fig. 2. Abrupt Wave Traveling Upstream from the Gate Following an Instantaneous Decrease in Discharge

Calling the mass of water, M, the unbalanced force required to change its momentum in one second is

$$F = M(V_2 - V_1) = \frac{(v_w - V_2)D_2w\,(V_2 - V_1)}{g} \quad . \; . \; [3]$$

where w is the unit weight of the water and g is the acceleration due to gravity. The unbalanced force is equal to the difference in hydrostatic pressures on areas numerically equal, respectively, to D_2 and D_1, or

$$F = \frac{D_2^2w}{2} - \frac{D_1^2w}{2} \quad . \; . \; . \; . \; . \; . \; [4]$$

Equating the values of F in Equations 3 and 4 and reducing,

$$\frac{g}{2D_2}\,(D_2^2 - D_1^2) = (V_2 - V_1)\,(v_w - V_2) \quad . \; . \; . \; [5]$$

Substituting for V_2 from Equation 2 and simplifying,

$$(v_w - V_1)^2 = \frac{gD_2}{2D_1}\,(D_2 + D_1) \quad . \; . \; . \; . \; [6]$$

In this equation, $(v_w - V_1)$ is the velocity of the wave as related to the velocity of the water in the shallower

part of the stream. Equation 6 is general and applies to all cases of abrupt waves.

For an abrupt wave traveling upstream, as illustrated in Fig. 2, if velocities in the direction of flow are considered to be positive and those in the opposite direction to be negative, the left-hand member of the equation will be $(-v_w - V_1)^2$, or $(v_w + V_1)^2$. In the case of the hydraulic jump, $v_w = 0$, and the left-hand member of the equation becomes V_1^2. If v_w is equal to zero, Equation 6 can be transformed to

$$D_2 = -\frac{D_1}{2} + \sqrt{\frac{2V_1^2D_1}{g} + \frac{D_1^2}{4}} \quad . \; . \; . \; . [7]$$

which is the more common form of the hydraulic jump formula.

Equation 6 can be obtained directly from Fig. 2 as readily as from Fig. 1. It will be observed from Fig. 2

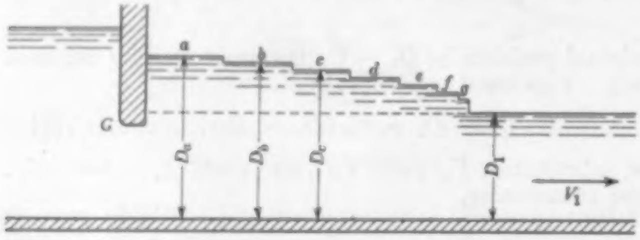

FIG. 3. A WAVE FOLLOWING A GRADUAL INCREASE IN DISCHARGE

Traveling Downstream from the Gate G

that the mass of water decelerated in one second is $\frac{(v_w + V_2)\, D_2 w}{g}$. Equation 6, solved for v_w, becomes

$$v_w = \pm \sqrt{\frac{gD_2}{2D_1}(D_2 + D_1)} + V_1 \quad . \; . \; . [8]$$

Considering motion in the direction of flow as positive and that in the opposite direction as negative, the plus sign before the radical applies to waves traveling downstream and the minus sign to those traveling upstream. As the value of D_1 approaches that of D_2 as a limit, Equation 8 becomes

$$v_w = \pm \sqrt{gD_2} + V_1 \; . \; . \; . \; . \; . \; . [9]$$

If the gate is opened gradually instead of instantaneously, as indicated in Fig. 1, the additional water can be assumed to pass down the channel in a series of waves, $a, b, c, d, \ldots$ (Fig. 3), the depths of water at each being, respectively, $D_a, D_b, D_c, D_d, \ldots$; and the velocities in the channel at the waves, $V_a, V_b, V_c, V_d, \ldots$ The velocity of wave a, from Equation 9, is $\sqrt{gD_a} + V_b$; and that of wave b is $\sqrt{gD_b} + V_c$, and so on.

Since the depth at any wave is greater than that at the wave next below, the velocity of any wave is greater than the velocity of the wave next below. Each wave therefore tends to overtake the waves ahead, and the distances between waves thus become progressively shorter. If the channel is long enough, all the small waves will combine into one larger wave. A corresponding condition will result if the gate in Fig. 2 is gradually closed. The ultimate tendency, therefore, is for flow to change with one abrupt wave, as illustrated in Figs. 1 and 2, even when the gate opening is changed gradually.

When a rectangular channel is carrying water under known conditions, and the flow through the intake is suddenly increased or the flow through the outlet is suddenly decreased by a given amount, neglecting the effects of friction, the depth, D_2, of water back of the wave and the velocity, v_w, of the wave can be determined by the simultaneous solution of Equations 1 and 6 or of 1 and 8. An equation in which D_2 is the only unknown quantity can be obtained by eliminating v_w from Equations 1 and 6, but this equation cannot be reduced to simple terms.

If the depth of water, D_1, is suddenly increased to a new depth, D_2, the velocity of the wave is given by Equation 8. Substituting this velocity in Equation 1, the new discharge, Q_2, can be determined. A good illustration of the effects of suddenly increasing the depth is afforded by the bore that forms at the mouths of tidal streams following a rapid rise in tide. If velocity in the direction that the stream flows is considered positive, v_w, as given by Equation 8, will be negative; that is, the wave will travel upstream. The new velocity, V_2, as given by Equation 2, may be either upstream or downstream, depending on the discharge of the stream and the amount that the depth is increased.

THE SLOPING WAVE

The conditions illustrated in Fig. 4 are the same as those previously described for Fig. 1, except that the gate opening is suddenly decreased instead of increased. The discharge per foot width of channel is decreased from Q_2 to Q_1, and the corresponding velocity from V_2 to V_1. The change in flow acts to decrease the depth from D_2 to D_1 and causes a sloping wave of deceleration, ab in Fig. 3, to travel down the channel.

Conditions at the end of one second are illustrated in this diagram. The line fg, representing the mean position of the wave, is so drawn that the areas amf and bmg are exact. The mean velocity of the wave is v_m. During the first second of decreased discharge the volume of water entering the channel is $Q_1 = V_1D_1$, and the decrease in volume is

$$Q_2 - Q_1 = v_m(D_2 - D_1) \; . \; . \; . \; . \; . [10]$$

Assuming that the mass of water, $cdef$ (Fig. 3), has had its velocity reduced from V_2 to V_1, and following the method previously described for abrupt waves,

$$v_m = \pm \sqrt{\frac{gD_1}{2D_2}(D_2 + D_1)} + V_2 \quad . \; . \; . [11]$$

Since the assumptions made in deriving this equation depart widely from actual conditions for large differences in depth, the formula is not generally applicable. In the limiting condition, however, for waves of infinitesimal height, the difference between actual and assumed conditions disappears and the velocity of the wave is:

$$v_w = \pm \sqrt{gD} + V \; . \; . \; . \; . \; . [12]$$

where D and V are respectively the depth and velocity of the water at the wave.

It can be assumed that the wave illustrated in Fig. 3 is made up of a large number of very small waves. Then, from Equation 12, the bottom wave will have a velocity of $v_a = \pm \sqrt{gD_1} + V_1$, and the top wave will have a velocity of $v_b = \pm \sqrt{gD_2} + V_2$. Assuming a straight-line variation between v_a and v_b, the mean velocity of the wave ab is

$$v_m = \frac{1}{2}(v_a + v_b) = \frac{1}{2}(\pm \sqrt{gD_1} + V_1 \pm \sqrt{gD_2} + V_2) \quad . \; . \; . [13]$$

Since D_2 is greater than D_1, v_b is greater than v_a, and the slope of the face, ab, of the wave becomes progressively flatter. At the end of two seconds the wave will have the position $a'b'$, and after a short time it will be discerned only by a gradual lowering of the water surface.

For the case illustrated in Fig. 4, the signs before the radicals are positive, considering velocities in the direction of flow as positive and those in the opposite direction as negative. For a sloping wave traveling upstream, such as would be produced if the gate opening in Fig. 2 were suddenly increased instead of decreased, the signs before the radicals are negative.

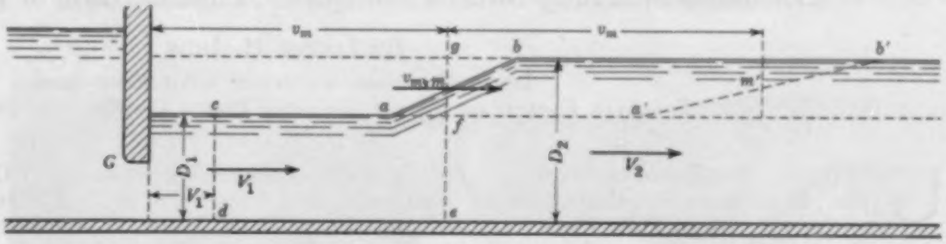

Fig. 4. A Sloping Wave Traveling Downstream from the Gate G Following an Instantaneous Decrease in Discharge

The wave ab has a curved face, and Equation 13 is therefore not exact. However, this equation has the advantage of being simple of application and will be found exact enough for ordinary problems. By the simultaneous solution of Equations 10 and 13, any two unknown quantities can be determined when the other quantities are known. Velocities of the top and bottom of the wave, respectively, are given by Equation 12 when D_1 and D_2 are known.

EFFECT OF CHANNEL FRICTION

Channel friction has a modifying effect on the height and velocity of a wave and the profile of the water surface behind it. To determine the profile of the water surface, reaches of the channel must be investigated at the end of successive time intervals. As a starting point, the depth back of the wave and its velocity can be obtained with friction neglected. The results can then be modified to include friction. In all cases where the effects of friction are to be considered, it is necessary for the flow to conform to the Manning formula (or some other open channel formula) in addition to the equations applying to the wave itself. Several trials may be necessary to secure values that will satisfy the various equations.

The effects of channel friction increase greatly as D_1 decreases. In deep water, for waves of moderate height, the velocity of the wave varies approximately as the square root of D_2, and considerable change in depth is required to affect the velocity materially. In such cases, where the velocity of the wave only is required, the effects of channel friction frequently can be neglected. If D_1 is small, and particularly where D_2 is large in comparison with D_1, friction materially modifies the velocity of the wave as well as the water-surface profile, and conditions must be investigated in short reaches. The principles involved in computing the water profile back of a wave are comparatively simple, but the computations may be extremely long and tedious.

In Equation 8, v_w increases as D_1 decreases, and becomes infinite for $D_1 = 0$. Also, from Equation 2, it can be shown that as D_1 decreases, V_2 approaches v_w and becomes equal to it under limiting conditions. For very small values of D_1, therefore, the friction loss due to the high velocity, V_2, of the water back of the wave so modifies conditions that Equation 8 no longer holds and an abrupt wave cannot form. The common observation that when a dam has failed the flood approaches in a "wall of water" can be correct only to the extent that an abrupt wave forms to accelerate the water already in the stream. The height of the wave depends on the depth of the water in the channel when the additional water arrives, as well as on the amount of this additional water.

Some Illusive Types of Waves Form in Conduits

Upper left: Fish-tail wave in the foreground, diamond-back waves farther along, and a hydraulic jump in the distance. Above: Stationary waves in water moving about 9 ft per sec. The difficulty of measuring the slope of the water surface is obvious. Left: Permanent swells at a transition between conduit and flume without "white-water" losses. What causes these waves to form?

Photographs courtesy of Fred C. Scobey, M. Am. Soc. C.E.

Temiscouata Storage Dam on Sand Foundation

Articulated Sluiceway Structure in Quebec, Canada, Built of Reinforced Concrete

By Jasper H. Ings

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At the outlet of Lake Temiscouata, in Quebec, on a tributary of the St. John River, the St. John River Power Company recently constructed a low dam to regulate the flow of the river. This dam has an over-all length of about 1,114 ft, of which 614 ft consists of reinforced concrete sluiceways and 500 ft of rolled earth fill, all on a fine sand foundation except for three sluiceways and a log chute, which are founded on rock. Each sluiceway pier is free to settle independently, but all the panels are tied together by dovetailed joints in the foundation slab, which are sealed with asphalt. By means of stop logs, Lake Temiscouata can be raised about 6 ft above its low-water level.

Until the Temiscouata Dam was placed in service, the output of the Grand Falls Plant of the St. John River Power Company was governed by the low and unregulated flow of the St. John River. The dam is situated at the outlet of Lake Temiscouata to the Madawaska River, a tributary of the St. John River, in the county of Temiscouata, Province of Quebec. This storage structure was made necessary by the demand for more power from the Grand Falls plant, in the Province of New Brunswick. The dam has a capacity of 87,000 acre-ft, and its completion will raise the flow of the St. John River from the ordinary minimum of about 1,200 cu ft per sec to 2,200 cu ft per sec.

The first surveys for the project were made in 1926, when the Montreal Engineering Company covered the reservoir location, and the New Brunswick Electric Power Commission investigated the proposed dam sites. Further surveys and borings were carried out by the St. John River Power Company in 1928, when sufficient data were obtained to definitely locate the dam site and to decide on the type of structure to be used.

General Descripton of the Dam

With the exception of the sluiceways founded on rock on the west bank, the structure as finally built consists of three principal parts, each of which rests on a sandy or permeable foundation. In the central river channel is located the main dam, a reinforced concrete sluiceway, built on an articulated or jointed mat, and immediately downstream is a jointed apron 45 ft wide, protecting the rear of the structure from the erosive effects of high discharges. On the east bank is the third section of the dam, a rolled-fill earth embankment extending to high ground. The general arrangement may be seen from the half plan and elevation in Fig. 1 (*a*) and (*b*).

The sills of the sluiceway (Fig. 2) are at the same elevation as the original river bed, and the total area of the sluice openings is about 25 per cent greater than the original cross section of the river. This percentage was considered an ample margin of safety against any loss of head or undue flooding in the reservoir, since a study of the river characteristics revealed that the critical section was downstream from the dam. It is not the intention to raise the regulated reservoir level above previous high-water marks.

During the course of the preliminary studies, the original test-pit and drilling work of the New Brunswick Power Commission was extended, both at the present site and at other possible locations. The final choice, however, was mainly governed by the smaller amount of steel-pile cut-off that would have to be driven and by the advantage of having one abutment on rock.

Contributory to the three primary structures are the steel sheet-pile cut-off, the various guard walls, and the simple slab deck, the functions of which are clearly indicated in Figs. 1 and 2.

Engineering Features of Design

Examination of the dam site indicated that the basic problem was the foundation material and its effect on any structure that might be built across the stream. A careful survey by wash borings and sampling was therefore made for every 50-ft section across the entire river, and the borings were plotted to show the varying changes in the strata of sand, clay, and rock. The sand samples were then sent to the Department of Public Works at Ottawa for a sieve analysis, from which a study was made of the percolation velocities that would obtain through the sand under the dam proper. In this study the value of the steel sheet-pile cut-off was disregarded. The method and formulas used in the design were taken from the paper on "The Design of Earth Dams," by Joel D. Justin, M. Am. Soc. C.E., published in the Transactions of the Society, Vol. 87 (1924), page 1.

The sieve analysis showed the effective size and porosity of the material, and from these data as a starting point, by applying Slitcher's formula to a unit area, a value was found for the velocity of percolation. In this fashion values of velocity were computed for each 50 ft of length of the dam, the maximum value found, under

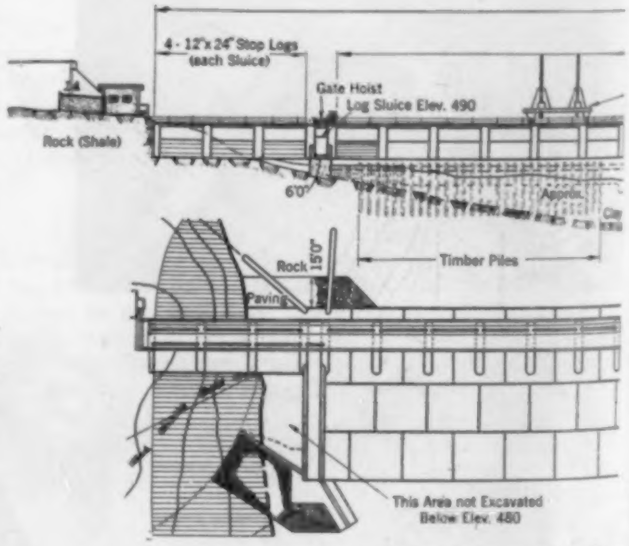


Fig. 1. The Temiscouata Dam
Consisting of a Reinforced Concrete

a 10-ft head, being 0.045 ft per min with a water temperature of 60 F. This of course is far below the velocity required to move the finest silt.

In order to ascertain the load that could be carried by the material of the river bed, a series of bearing tests was made. The usual method was followed; that is, a known area was subjected to known loads and the extent of the settlement was observed. The sand at the dam site sustained a load of 2,500 lb per sq ft with no settlement.

After establishing the limit of safety of the foundation material, the next step was to select the type of structure and its stability features. This choice was governed by local foundation conditions and by the conditions of operation and use that would obtain when the structure was completed. That is to say, the effects of local settlement under each part had to be provided for so as to minimize any damage that might result and prevent failure of the whole structure. The demands of operation required the use of any, or all, of the sluices in time of flood.

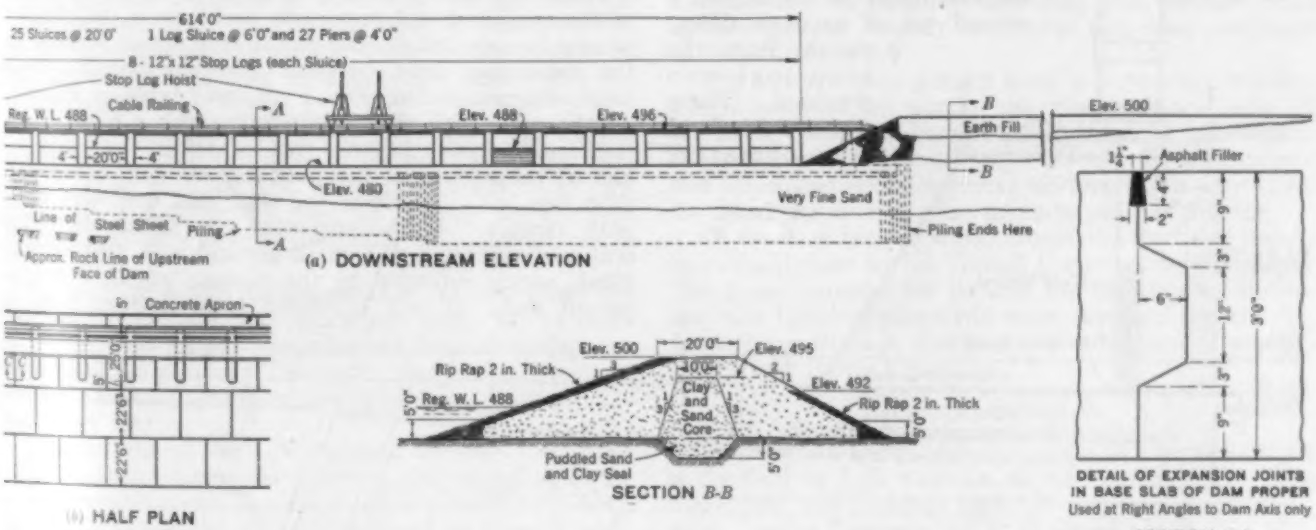
Preliminary investigations included studies of timber and steel dams, and four types of concrete structures. The conclusions reached were embodied in the final design. Provision was made for the effect of local settlement by dividing the dam into panels or units at each sluice, so that any movement of the base and pier would be reflected in but two sluices at the most. Each unit is stable against sliding or overturning and is free to move under the deck.

To guard against damage by erosion from high discharge velocities, strict adherence to a fixed operation procedure is enforced. This procedure may be summarized as follows. All sub-normal and normal discharges are passed through the sluiceways that are founded on rock, and serve to build up a water cushion below the dam. Then all excess flows are distributed across the entire dam by the removal of one stop-log at a time from each sluiceway; that is, all the logs numbered one and two are lifted before any number three's are touched. This method of operation ensures that full advantage will be taken of the water cushion and that each of the sluices founded on sand will pass a minimum of flow.

Downstream View of the Temiscouata Dam, Nearly Completed

Any small, sudden increase in flow that would top the stop-logs would not be dangerous, as such small amounts of energy would be largely dissipated by impact on the sluice floor, and the water would have a low velocity by the time it reached the downstream edge of the apron. It was this latter consideration that governed the length of the apron, the calculations for which were based on the studies and experiments carried out by the Miami Conservancy District and published in its Report No. 3.

The correctness of these measures has been amply proved in the two years that the dam has been in operation, for no settlement, heaving, or erosion of any consequence has occurred; in fact, several depressions resulting from the removal of the cofferdam, below the dam



at the Outlet to Lake Temiscouata, Province of Quebec
Sluiceway, a Jointed Apron, and an Earth-Fill Embankment

proper, were silted up again, thus proving the absence of high velocities beyond the end of the apron.

In computing the stability of the dam, all studies were based on one complete panel, that is, on one pier and the adjacent half base and deck slab on each side, a unit length of 24 ft. After considerable thought it was decided to neglect the restraining effect of the steel sheet-pile cut-off against both overturning and sliding, since the value of such restraint in either uplift or bending is variable across the length of the dam and uncertain for the particular material of the river bed. In fact, the steel piling was merely considered as constituting an extra margin of safety, both to increase stability and to prevent percolation or flow under the base slab.

In the calculations, the maximum possible head was assumed to be 10 ft, and the toe of the dam was assumed to be at the downstream edge of the foundation slab, that is, at the joint between the dam proper and the apron. Consideration was given to the water load in front of the stop-logs, to the possibility that one sluice would run full while the adjacent one would be empty, and to the effect of ice pressures. The maximum pressure exerted on the sand foundation was found to be 1,140 lb per sq ft, an amount well below the value of 2,500 lb per sq ft shown by bearing tests.

After the type, stability, and general feasibility of the structure had been determined, the preliminary design was submitted to several consulting companies for comment. From their reports a table was drawn up, listing the firms and their various comments. A careful study of the data and suggestions thus tabulated revealed that but very few minor changes were really called for. This method of checking the ideas collected made it possible to cancel those that reflected individual bias and special "brain waves," leaving only the ones required for a sound and practical structure.

SECONDARY STRUCTURES DESCRIBED

Among the secondary structures are the rock-section sluices, the guard walls, the log chute, the earth-dam abutment, and the earth dam itself. The sluices built on rock differ from the others in that they do not have a downstream apron. Also, for these sluices the base slab was carefully drained to prevent the building up of harmful uplift pressures, and a second set of grooves downstream from the stop-logs was provided. These were added in case operating conditions at some future date should allow the use of gates in this non-scouring section, thus permitting easier regulation and faster discharge of flow through the dam.

The log chute, as shown in Fig. 1, performs three separate functions. Its primary duty is of course to pass logs, but by the inclusion of suitable grooves and variable stop-logs it can also be used as a fishway. Again, because it extends to the end of the apron and to bedrock, it acts also as a guard and deflecting wall, protecting the apron from undermining and from the high velocities of concentrated discharge in the rock sluices.

FOUNDATION COFFERDAM DRAINED WITH WELL POINTS
Extreme Cold Weather Required That Well Points Be Covered and Steam Heated

The purpose of the abutment at the east end of the dam is to tie together the sheet-pile cut-off, the end of the dam, and the earth-fill embankment. Essentially it consists of a thin curtain wall, 44 ft long, built on top of the steel piling, and a supporting pier forming a blank sluice panel. The base slab and the apron were carried to the shore line of the supporting pier. The slopes of the embankment were then brought down and around these walls to make the path of leakage sufficiently long to prevent actual flow.

The earth-fill embankment was built with a cut-off trench and core section of puddled and selected material backed on both sides with rolled fill. The whole embankment, both upstream and downstream, is protected by a 2-ft layer of riprap, as shown in Fig. 1 (*c*).

WATER SEAL AT EXPANSION JOINTS

In an articulated dam such as is here described, one of the small but still important problems is the placing of an adequate but flexible seal to stop actual leakage at the expansion joint between adjacent panels. This joint, diagrammed in Fig. 1 (*d*), was built as follows. At the mid-depth of the foundation slab a 6 by 12-in. tongue-and-groove keyway was formed in the concrete, and at the surface of the joint a 2 by 4-in. dovetailed void was left. To effect the seal, this void was filled with asphalt. At the upstream side of the dam this seal was connected to a small vertical well, also asphalt filled, which extended to the bottom of the concrete cut-off wall. It will be noted from Section A-A, in

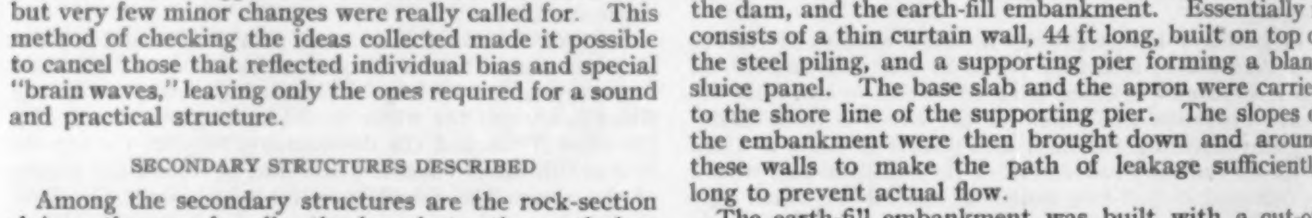


FIG. 2. SECTION A-A, THROUGH THE SLUICEWAY OF THE TEMISCOUATA DAM
Sills Are at the Elevation of the Original River Bed

Fig. 2, that this type of joint was not used in any of the apron joints, but only in the foundation slab. There is no tie between the apron and the dam proper.

Where the panel joints cross the stop-log sill, flexibility is required in two planes. Not only was water-tightness needed, but also protection for the steel H-beam sill against undue distortion by any subsequent movement. Here again a heavy 6 by 10-in. dovetail at right angles to the expansion joint was used. After the sides and bottom of the dovetail had been heavily asphalted, the H-beam was placed at its proper elevation and grouted into place (Fig. 2).

The west end of the dam, near the log chute, was supported on wooden piles for a distance of about 125 ft. It will be noted from Fig. 1 that in this area the underlying clay stratum approaches the surface. Construction operations revealed that this area could not be concreted without some initial settlement, and therefore the use of piles was clearly indicated.

The steel sheet-pile cut-off, or curtain wall, was driven from the east side of the log chute to the earth dam, using steam driving heads throughout. The lengths of the piles were obtained from the boring cross section, and the minimum penetration into clay was specified as 5 ft. In the area of maximum velocity of percolation under the dam, the penetration was about 17 ft. The top of the piling as driven was cut off at the proper elevation and incorporated in the bottom of the concrete cut-off. Although great care was taken with the driving operations, it is fully realized that the actual water-tightness of such a seal, as shown in Fig. 2, is to some extent problematical.

OUTLINE OF THE STRUCTURAL DESIGN

No unusual features of structural design were encountered, since all the various elements were reducible to the principle of the simple beam or the cantilever. The general design may be subdivided and briefly described as follows:

1. The piers are designed to carry the whole load of water and ice pressure and to transmit it to the base slab. That part of the pier downsteam from the stop-logs is further designed to provide for the condition of full flow in one sluice while the adjacent one is empty.

2. The base slab is designed (*a*) to distribute the foundation reaction over the whole slab; (*b*) to carry one complete sluice, assuming settlement under one pier; and (*c*) to carry the water load either above or below the slab, assuming settlement or uplift as the case may be.

3. The cut-off wall is designed so that the whole volume of sand downstream from it, and extending to the end of the apron, can be considered as preventing sliding, or in other words, the cut-off is designed to provide additional resistance to sliding, no allowance being made for the effect of the steel sheet piling.

4. The hydraulic design of the apron has already been discussed. Its structural design was very simple, as no steel or grooving was used at the joints.

5. The deck system consists of a series of simple concrete beams and is entirely independent of the piers. The deck loading was taken as that due to the stop-log hoist and the stacked stop-logs. Over the log chute it was necessary to use tension dowels to prevent this short slab from being lifted by the forcing down of the gate.

VIEW OF THE DAM FROM UPSTREAM
Water at Regulated Level, 8 Ft Above the Original Stream Bed

CONSTRUCTION FEATURES EXPLAINED

As regards construction features, those of the greatest general interest relate to the necessity for draining the inside of the cofferdams. Since there was always a large area of river bed exposed under a 10-ft head, there was a natural tendency for sand boils to form. The head, combined with the high elevation of the water table, made drainage a difficult problem. An effort was made by means of a sump, ditches, and pumps to dry up the excavation needed for the cut-off wall and base, but this was unsuccessful. Resort was then had to pumping from a multitude of carefully laid out well points. This method proved entirely successful and was continued to the end of the job.

The concrete was poured from a temporary wooden trestle constructed across the river on the axis of the dam. A derrick barge was employed for building the cofferdam and for pile driving. As most of the concrete was placed between December 1929 and February 1930, the usual precautions were taken to prevent freezing.

All the construction work, except the electrical installation, was done by the Domill Construction Company. The power outlets, the fixtures for the stop-log hoists, and the lighting standards were installed by the St. John River Storage Company, a subsidary of the St. John River Power Company.

ACKNOWLEDGMENTS

The St. John River Storage Company was represented in the field by J. B. Barnum, as resident engineer. The whole dam was designed under the supervision of R. H. Reid, Design Engineer, by L. H. Burpee, Jun. Am. Soc. C.E., and the writer, who were under the direction of Walter Blue, Manager of Development, Gatineau Power Company, Ottawa.

Rainfall and Crop Yields

Analysis of Long Records Shows Little Correlation

By I. Gutmann

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This analysis by Mr. Gutmann, covering crop records extending over half a century in England, indicates that such records cannot be depended upon as an index of annual rainfall, at least in a humid climate. There is, however, a faint indication that the yields decreased with increased rainfall, a result corroborated by a study of the growth of the yew, which in seasons of heavy rainfall produced thinner annual rings. Crop yields are of course influenced by climatic factors other than rainfall, such as frost, heat, and winds, as well as by biological conditions and agricultural methods. Mr. Gutmann also makes reference to the crop records of the old California missions, in which the yield curves for different crops show no discoverable correlation.

There is a dictum in hydrological literature that an unbroken series of 30 rainfall seasons is sufficient to determine the rainfall characteristics of a locality. Recent studies of cyclic tendencies in rainfall suggest a modification of this statement. It has been discovered that the duration of apparent rainfall cycles may exceed a period of 30 years. Thus, in a study of rainfall at San Francisco, which I made in 1915 and 1916 for the Spring Valley Water Company of that city, it was found that the average annual rainfall for the 23-year period of 1866–1889 was 25.14 in., while that for the immediately succeeding 23-year period (1890–1913) was 19.76 in. This indicates an apparent rainfall cycle of 46 years, with a difference of some 25 per cent between its two phases.

Similar observations have been made by others, notably H. B. Lynch, M. Am. Soc. C.E. In *Rainfall and Stream Run-Off in Southern California Since 1769*, his published report to the Metropolitan Water District of Southern California, made in 1931, he was led to surmise "a cyclic period up to perhaps eighty years" in the rainfall of southern California.

With these observations in mind it appears obvious that in planning perennial storage works, or similar

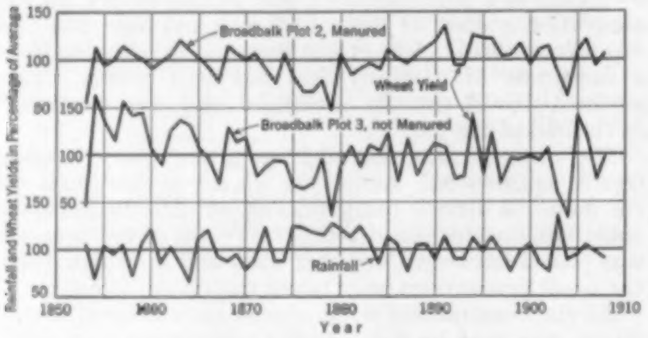


Fig. 1. Annual Rainfall and Wheat Yields
At the Rothamsted Experimental Station, Harpenden, England

hydraulic undertakings, rainfall records far exceeding 30 years in duration are more than desirable.

That this information is of more than scholastic interest and that it may be of crucial importance to planners and financial promoters of water supply and irrigation projects, hydro-electric power developments, flood control systems, and similar undertakings, has been proved by experience in many lands. All too often such information is required for regions with no adequate rainfall records, or with none at all for hundreds of miles around. Yet the acceptance and financing of a project may depend entirely on the appraisal of the rainfall of a watershed. Financiers should know the phase of the rainfall and run-off cycle at the time the proposed plant is to begin operating. It is worth knowing, when starting a hydraulic enterprise, whether a dry or wet phase of rainfall cycle is in progress.

Available Rainfall Indices

In a predicament of this kind, one is likely to begin casting about for indices of rainfall for which long-range records may be in existence. The fluctuation of lake levels, the thickness of tree rings, and records of crop yields are generally thought of in this connection. Of these, crop records deserve particular attention because not infrequently reliable crop data may be found in localities having no rainfall records; and moreover, crop records antedating existing rainfall records may be available, thus suggesting the extension of a comparatively short rainfall series by an extrapolation based on crop yields.

This use of crop records was made the basis of my study in 1915 and 1916 for the Spring Valley Water Company on the rainfall régime of the San Francisco Bay region. At the suggestion of F. W. Roeding, head of the Agricultural Department of the company, the report was made to include a careful examination of the crop records of the central California missions of the Spanish Fathers, covering the period of 1776 to 1834. Recently these and similar records were also studied for the same purpose by Mr. Lynch. By a process too briefly outlined in his report, he translated the crop records into terms of rainfall, which he combined with existing rainfall and other records, thus producing a continuous record of annual rainfall and run-off covering a period of some 160 years, beginning with the rainfall season of 1769–1770.

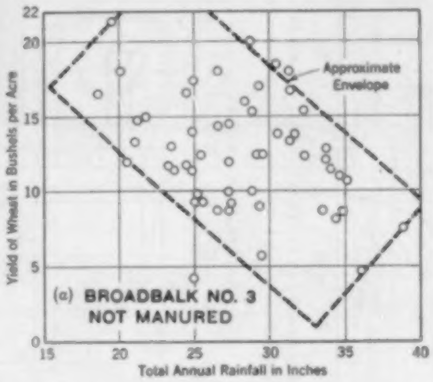
Of course any procedure of this nature presupposes the existence of a definite correlation between the rainfall and the crop yield for a given year or series of years. To test the validity of such an assumption, it would be necessary to have concomitant series of such records, that is, fairly long records of annual rainfall and crop yields covering the same period of years.

Analysis of an English Record Covering Over Half a Century

Fortunately such records exist—they are of great precision—and the test is possible. The Rothamsted Experimental Station of Harpenden, England, which is one of the world's leading agricultural research institutions, has kept precise records of rainfall and the yields

of various crops grown on its land since 1853. These records were made by highly qualified observers and their accuracy and reliability cannot be disputed.

In attempting to deduce the correlation, if any, between annual rainfall and crop yield, I made use of the rainfall series for the period of 1853 to 1908, inclusive, obtained from Dr. B. A. Keen of the Rothamsted Station, and of the simultaneous records of wheat yields of the parcels, "Broadbalk Plot 3" and "Broadbalk Plot 2," as given in Prof. C. G. Hopkin's book on *Soil Fertility and Permanent Agriculture.* The records of these particular parcels were selected for the following reasons. The parcel designated "Broadbalk Plot 3" was cropped continuously all these years without rotation, and without manure or any chemical fertilizer, that is, there were no factors to interfere with the "pure" relationship of annual rainfall to crop yield. The parcel labeled "Broadbalk Plot 2" was manured, thus approximating the practice of well managed farms, and illustrating a modified relationship between rainfall and crop yield.



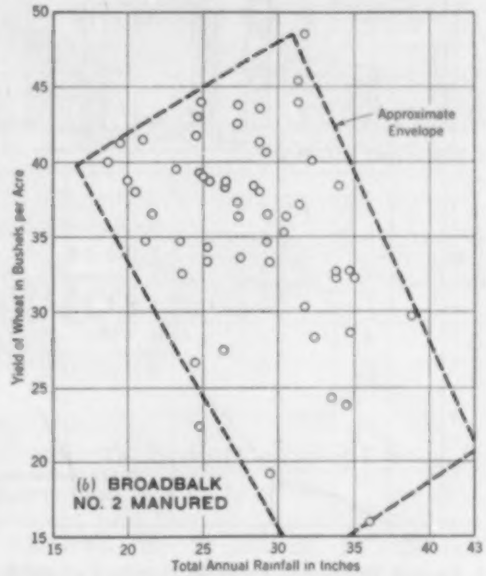


FIG. 2. RELATION BETWEEN WHEAT YIELDS AND RAINFALL

As Determined at the Rothamsted Experimental Station

(*a*) Broadbalk Plot No. 3, with No Rotation and No Fertilization;
(*b*) Broadbalk Plot No. 2, Manured

The three series of data given in Table I were first expressed in terms of percentage of their respective averages and were plotted on the same chart, Fig. 1. This chart shows a parallelism between the two crop yield curves, which may have been expected, but a lack of parallelism between either of these curves and the rainfall curve—which may seem surprising.

LITTLE PROMISE OF CORRELATION

In Fig. 2 crop yields are plotted as a function of annual rainfall, the abscissa representing rainfall in inches, and the ordinate crop yields in bushels per acre. These two charts, which are in fact rough graphical tests of correlation, show a widely scattered distribution through which no reasonable curve can be drawn, thus holding out little promise of correlation. Nevertheless, there appears to be a negative tendency, suggesting the likelihood of increased crop yield with decreasing rainfall.

These series of data were tested analytically by the well known Pearson formula for the correlation coefficient, written in this form:

$$r = \frac{\Sigma d_x d_y}{\Sigma d_x^2 \Sigma d_y^2}$$

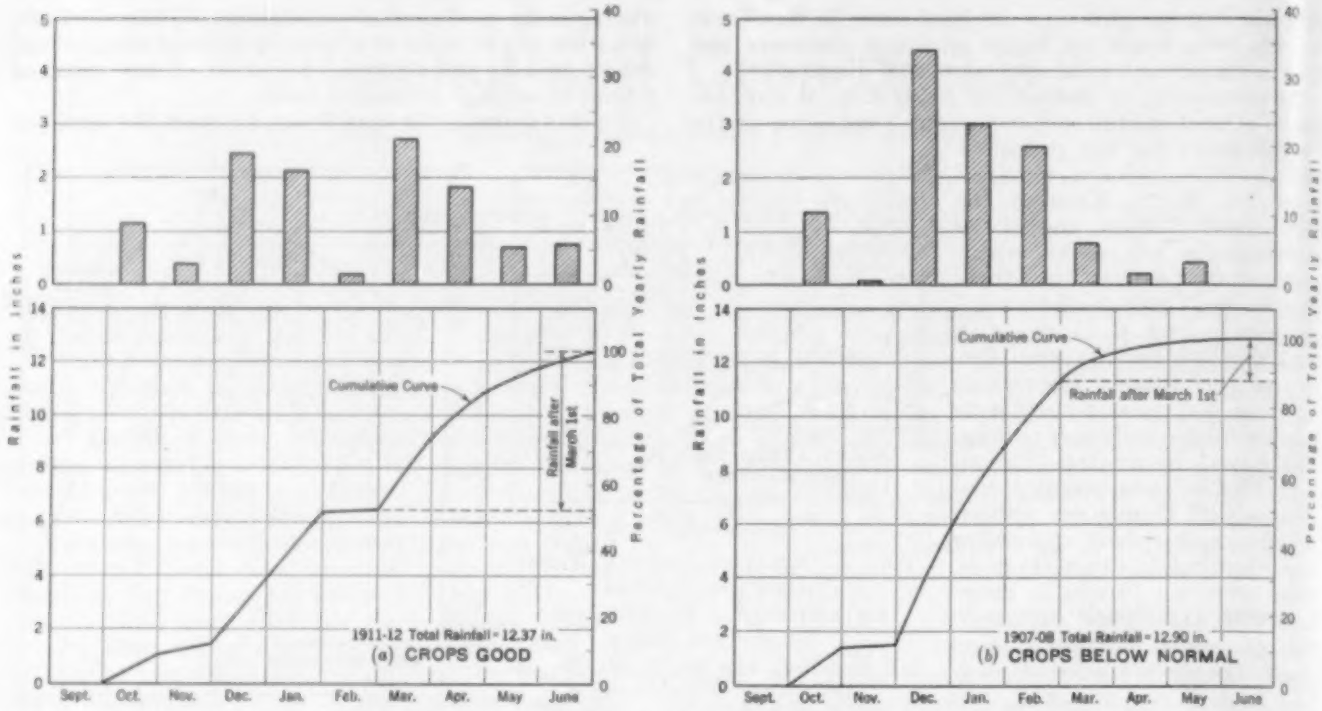
TABLE I. RAINFALL AND YIELDS OF WHEAT AT THE ROTHAMSTED EXPERIMENTAL STATION, HARPENDEN, ENGLAND

Year	Total Annual Rainfall Inches	Yield in Bu per Acre: Broadbalk Plot 3 (Not Manured)	Yield in Bu per Acre: Broadbalk Plot 2 (Manured)	Year	Total Annual Rainfall Inches	Yield in Bu per Acre: Broadbalk Plot 3 (Not Manured)	Yield in Bu per Acre: Broadbalk Plot 2 (Manured)
1853 . . .	29.36	5.9	19.1	1881 . . .	31.66	13.8	30.3
1854 . . .	19.38	21.1	41.1	1882 . . .	34.77	11.0	32.8
1855 . . .	29.17	17.0	34.6	1883 . . .	30.35	13.9	35.3
1856 . . .	27.22	14.5	36.3	1884 . . .	23.60	13.0	32.5
1857 . . .	28.84	20.0	41.3	1885 . . .	32.10	15.3	40.1
1858 . . .	20.04	18.0	38.8	1886 . . .	29.14	9.0	36.5
1859 . . .	30.50	18.4	36.3	1887 . . .	21.05	14.9	34.8
1860 . . .	33.85	12.9	32.3	1888 . . .	28.88	10.0	38.0
1861 . . .	23.56	11.4	34.9	1889 . . .	29.13	12.3	40.5
1862 . . .	28.32	16.0	38.4	1890 . . .	24.78	14.0	43.0
1863 . . .	24.95	17.3	44.0	1891 . . .	31.86	13.8	48.5
1864 . . .	18.56	16.5	40.0	1892 . . .	25.29	9.4	33.4
1865 . . .	31.22	13.4	37.1	1893 . . .	25.10	9.8	34.3
1866 . . .	33.81	12.1	32.6	1894 . . .	31.22	18.0	45.5
1867 . . .	26.44	8.9	27.5	1895 . . .	27.16	10.0	43.9
1868 . . .	24.59	16.6	41.8	1896 . . .	31.33	16.8	44.0
1869 . . .	26.48	14.3	38.3	1897 . . .	27.17	8.9	37.3
1870 . . .	21.67	15.0	36.5	1898 . . .	20.49	12.0	38.0
1871 . . .	25.00	9.4	39.0	1899 . . .	27.13	12.0	42.5
1872 . . .	35.03	10.8	32.4	1900 . . .	29.34	12.3	33.3
1873 . . .	24.57	11.8	26.8	1901 . . .	23.15	11.8	39.6
1874 . . .	24.78	11.5	39.3	1902 . . .	20.97	13.3	41.5
1875 . . .	34.94	8.6	28.9	1903 . . .	38.69	7.6	29.7
1876 . . .	34.41	8.1	23.9	1904 . . .	24.93	4.2	22.3
1877 . . .	33.46	8.9	24.1	1905 . . .	26.44	18.0	38.5
1878 . . .	32.33	12.4	28.3	1906 . . .	28.95	15.2	43.6
1879 . . .	36.04	4.8	16.0	1907 . . .	27.41	9.1	33.7
1880 . . .	33.97	11.5	38.4	1908 . . .	25.31	12.4	38.6

where r is the coefficient of correlation; d_x, the algebraic deviation of any value of x from its average arithmetical value; and d_y, the algebraic deviation of any value of y from its average arithmetic value.

By this formula the correlation between the series of annual rainfall and crop yields of the plot, Broadbalk 3 (not manured), is $r = -0.322$. The probable error, computed by the formula, P.E. $= 0.6745 \dfrac{1 - r^2}{\sqrt{n}}$ (where n stands for the number of terms in the series) is ± 0.082. Therefore, the correlation coefficient, r, equals -0.322 ± 0.082, which is decidedly low, particularly since the coefficient of correlation is not quite four times the probable error. As Professor H. Secrist states in his *Introduction to Statistical Methods,* on page 429, "It has become conventional to say that for r to be significant it must be at least six times its probable error." It should be recalled that, for perfectly correlated series, r would have a value of ± 1.000, as against the value found here, which may be as low as -0.240.

Thus, my analysis indicates a very low degree of correlation between annual rainfall and crops. Moreover, whatever correlation there may be is of a negative or regressive character. This probably signifies that at the Rothamsted Experimental Station and in localities of similar climate, crops are more likely to suffer from an excess, than from a deficiency, of rainfall. This rather surprising conclusion seems to be borne out by a study made by E. G. Burtt and J. Glasspoole,



A Typical Dry Year (1911–1912), with Favorable Distribution of Rainfall, Resulted in Good Yields

Same Annual Rainfall in 1907–1908, Unfavorably Distributed Gave a Poor Crop Yield

FIG. 3. INFLUENCE OF DISTRIBUTION OF ANNUAL RAINFALL ON CROPS AT NILES, CALIF.

published in the *Meteorological Magazine* for March 1928, on the relation of annual rainfall to the thickness of annual rings of trees in the Forest of Dean, England, for the period of 1830 to 1920. One of the conclusions of the study was that "There are some indications that heavy rainfall is inimical to the growth of the yew." The yew referred to in this case had had a continuous record of growth from 1740 to 1920.

Of course these crop and rainfall records at Rothamsted are representative of a distinctly humid climate. In arid regions the correlation between crops and annual rainfall might be different and perhaps more satisfactory, but while the possibility of such difference is readily conceded, the burden of proof is on those who assume, or claim, a dependable correlation between crops and annual rainfall.

The impression that fluctuations in crop yields vary to about the same degree as annual rainfall is not borne out by the Rothamsted records. Thus, the standard deviation of the rainfall series has been found to be 16.5 per cent of its arithmetical average, while the standard deviation of the crop series has been nearly 29 per cent of its arithmetical average. Obviously this means that crop yields are much more erratic than rainfall.

CROPS INFLUENCED BY NUMEROUS FACTORS BESIDES THAT OF RAINFALL

In trying to account for the more erratic nature of crop yields, it may be observed that besides their dependence on rainfall, crops may be greatly influenced by various other factors, such as wilting heat, killing frost, withering winds, unfavorable soil conditions, improper agricultural methods, rust and other fungus diseases, insect pests, rats, fires, and politico-economic conditions. Last but not least, excessive moisture and floods are just as harmful or even more harmful to crops than moderate drought. It is a matter of general experience, both in humid and in arid climates, that crops may be bad in a very wet year as well as in a dry year. This consideration alone has a radically disqualifying effect upon the use of crop records as an index of annual rainfall.

Above a certain minimum, subnormal rainfall, favorably distributed according to the requirements of plant growth, will produce better crops than a supernormal annual rainfall unfavorably distributed. Favorable distribution means above all adequate rains in the spring. Thus, in a study of rainfall and crop production in the agricultural district around San Francisco Bay, it was found that very satisfactory crops were produced in seasons when the rainfall was considerably below the average, provided the total rainfall for the months of March, April, and May was not less than 4 in. In the season of 1911–1912, Fig. 3(*a*), crops were good though the rainfall totaled only 12.37 in., which was about 62 per cent of the average for the region. The yields were good because about 50 per cent of these 12.37 in. fell after March 1. On the other hand, the season 1907–1908, Fig. 3(*b*), with a rainfall of 12.90 in., only 1.45 in. of which fell after March 1, produced poor crops.

The paramount importance of rainfall distribution has been long appreciated by agriculturists and statisticians, as witnessed by a number of studies on the effect of spring and early summer rainfall on the yield of barley, oats, and other crops, published in the *Journal of Agricultural Science* (Cambridge, England), in the *Journal of Agricultural Research* (Washington, D.C.), and in the *Journal of the Royal Statistical Society* (London), and other similar periodicals. It is noteworthy that agriculturists did not think of studying the relation between total annual rainfall and crop production. Apparently a correlation between these two factors did not seem reasonable or probable to them.

Finally, there is another highly disconcerting feature about crop records. When there are records of more

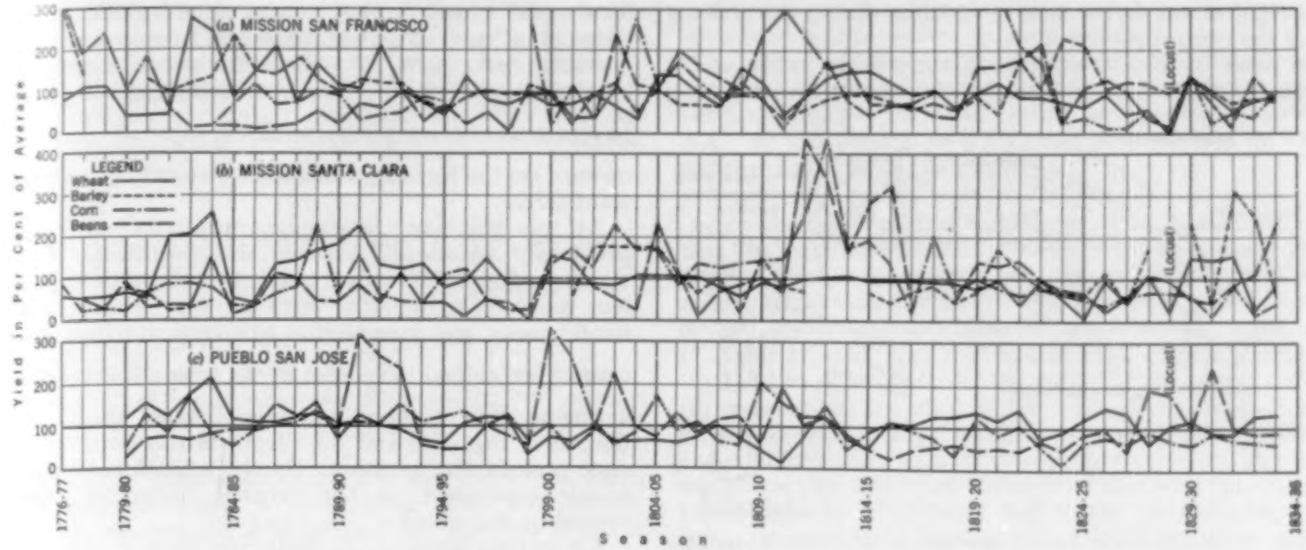


FIG. 4. SOME CROP YIELDS AT EARLY CALIFORNIA MISSIONS

No Rainfall Records Are Available But There Is No Apparent Relation Between the Yields of the Various Crops

than one crop for the same period and locality it may be well-nigh impossible to decide which of the crops should serve as a rainfall index. Yet a decision in this matter is all important, because it often happens that a heavy yield of one crop is simultaneous with a subnormal yield, or near-failure, of another raised in the same locality. On examining the crop records of Mission San Francisco (Fig. 4) for the period of 1776–1777 to 1833–1834, the following inconsistencies will be noted: during 1776–1777, the first season of record, the yield of wheat was about 80 per cent, while that of barley was about 310 per cent of the average for the series. Similarly, in 1782–1783 the yield of wheat was 280 per cent of the average, and that of barley 120 per cent, whereas that of corn was only 20 per cent. In 1824–1825 the yield of wheat was about 60 per cent of the average, that of barley 210 per cent, that of corn 40 per cent, and that of beans 110 per cent. Similar and even more striking discrepancies have been observed in the records of the Missions San José and Santa Clara, the Pueblo of San José, and the Presidio of San Francisco. Now what judgment, or even guess, can be ventured as to the annual rainfall when one grain crop is far above normal and another grain crop much below it, and when one summer crop is near normal while another similar crop is less than half of normal?

ENGINEERS' NOTEBOOK

From everyday experience engineers gather a store of knowledge on which they depend for growth as individuals and as a profession. This department, designed to contain practical or ingenious suggestions from engineers both young and old, should prove helpful in the solution of many troublesome problems.

Economy in Form Work for Multiple-Arch Dams

By FRED A. NOETZLI

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS

CONSULTING ENGINEER, LOS ANGELES, CALIF.

IN recent design studies for a fairly high multiple-arch dam, all the engineers connected with the work were agreed that satisfactory methods of analysis were available, and that a proper design according to these methods would result in a safe structure. It fell to my lot to study possible improvements in layout and construction features whereby further economies might be effected. Some designers of multiple-arch dams in the past have perhaps gone rather too far in the application of "thin" sections. To attempt economy in that direction was considered ill advised.

Studies of layout for the purpose of facilitating construction developed a proposed arrangement, as illustrated in Fig. 1. A certain part of the arch barrel is poured integrally with the buttresses, leaving a gap of uniform width to be closed subsequently by the central part of the arch barrel. The advantage gained by this arrangement is threefold: first, the middle of the arch barrel has a considerably decreased span and rise, so that the arch centering is much lighter than for the full arch; second, because of the uniform span of the middle part of the arch, from the top to the bottom of the arch barrel, the centering has a uniform span and can be readily raised step by step as the construction progresses; and third, the parts of the arch adjoining the buttresses are nearly straight and the form work is relatively simple and inexpensive.

Of course the sections of the arch barrel to be poured integrally with the buttresses must be short enough in relation to the thickness at the top of the dam so that they will be capable of supporting, either directly or with the aid of temporary bracing or anchorage, the

weight of one or two lifts of concrete during the pouring of the central part.

After the dam is completed, the stresses in the arches due to water load and weight of concrete are the same

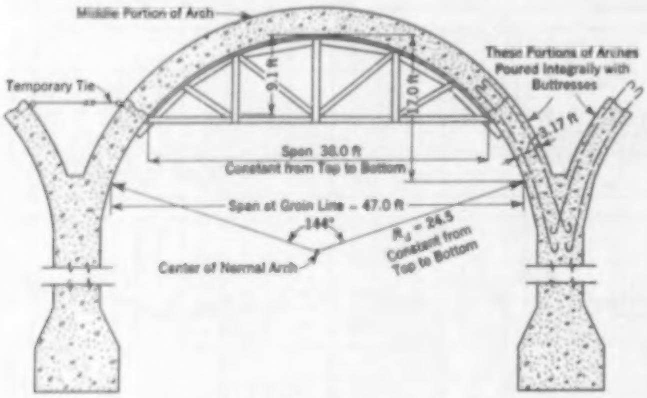


FIG. 1. A MOVABLE ARCH FORM FOR A MULTIPLE-ARCH DAM

as if the arches had been poured in the usual manner. There is, in fact, some advantage in the location of the joint in the arches at some distance from the face of the buttresses, where the maximum bending moments and arch stresses occur.

Further economy in multiple-arch dams would be possible by a more liberal assumption as to the permissible sliding factor for the buttresses, allowing a steeper upstream slope. Such a steeper slope, within reason, would decrease the influence of the dead load and of the variable water load on the arch stresses near the crest, and incidentally would result in a more favorable distribution of the principal stresses in the buttresses, thereby increasing the safety of the structure at no additional cost.

Portal Effect on Top-Chord Stresses

By B. J. LAMBERT

MEMBER AMERICAN SOCIETY OF CIVIL ENGINEERS
HEAD OF THE DEPARTMENT OF CIVIL ENGINEERING,
STATE UNIVERSITY OF IOWA, IOWA CITY

THERE seems to be a difference of opinion among engineers as to whether the wind forces transferred by the upper wind-truss system of a bridge to the hip joints cause stresses in the upper chord members due to overturning effect, commonly called portal action. During the past forty years some authorities have claimed that stresses are caused by this portal action, while others have claimed that there are no such stresses.

Consider the diagram, Fig. 1(*a*), in which the wind forces at $B'C'D'E'F'G'$ are brought to the hip joints B' and G' by the top lateral system, causing stresses in the horizontal truss, consisting of both upper chords and all its web members. The wind forces that have been brought to B' and G' must now be transferred to the bridge reactions through the portal $B'Baa'$ and its framing. The problem, then, may be stated as follows: Does this transfer of the horizontal force at B' and B cause the upper chord members $B'G'$ and BG to be stressed?

The argument or "proof" that such stresses are caused, runs somewhat as follows. The horizontal wind force equal to, say P, at B' causes equal horizontal reactions at a' and a. This horizontal couple causes an overturning moment, Ph. Since the bridge is supported at a' and a, there must be an equilibrating couple due to reactions at these points, with the value of $\frac{Ph}{K}$, acting upward on the leeward side and downward on the windward side.

At this point in the demonstration the authorities previously mentioned replace the horizontal couple which produced the vertical couple by a so-called "equivalent couple," acting in a vertical plane normal to the main trusses, and assume that two vertical forces of the couple, each equal to $\frac{Ph}{K}$, act at the hips, opposing those acting at the reactions and equilibrating them. The diagrams, Fig. 1(*b*) and (*c*), illustrate this point and at once prompt the question: Is the substituted vertical couple equivalent to the original horizontal couple caused by the wind?

Let us refer again to the horizontal force, P, at the hip, together with the horizontal forces, $\frac{P}{2}$, at each reaction. Now consider the portal frame consisting of end posts and portal bracing, and find what forces are necessary to keep it in equilibrium in the plane of the portal.

In a simple conception, the portal might be visualized as hanging from a wall, as in Fig. 1(*d*), and suspended on linkages. If the anchorages to the wall are in the plane of the portal framing, each horizontal reaction will be $\frac{Ph'}{K}$, where h' is the length of the end post. Because the balancing couples are in the same plane, there are now no outside forces at the hips required to keep the portal in position, and accordingly there are no stresses in the top chords.

The forces $\frac{Ph'}{K}$, in the plane of the portal, may now be split into two right-angled components, one of which will cause compression in the member a' b' (similar to the bottom chord on the windward side of bridge). At the point a, forces of equal amount but opposite in direction to those at a', are produced. The force P at the top of the portal, or hip, passes through the portal framing,

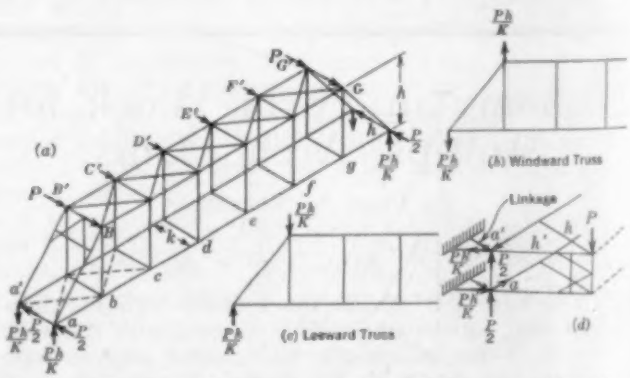


FIG. 1. SHOWING TRANSFER OF WIND STRESSES IN TYPICAL BRIDGE TRUSS

causing direct stresses and bending dependent on varying conditions, but these forces stay in the plane of the portal from the upper end to the lower or attached end. There is therefore no occasion for any exterior force or forces to keep the portal from moving.

According to the authorities mentioned, the stresses are not large. They might practically never be used in the design of the truss. That, however, has nothing to do with the problem. My contention is that the use of the "equivalent couple" is illogical, and that there are no stresses caused in the top chords by this portal action.

Welded Shear Reinforcement for Concrete Beams

By Dewey M. McCain

Associate Member American Society of Civil Engineers
Professor of Civil Engineering, Mississippi State College, State College, Miss.

Recent discussions of present practice in designing concrete beams to resist shear show conclusively that the engineering profession is not satisfied with the

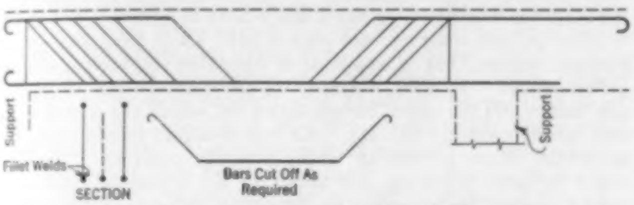


Fig. 1. Shear Reinforcement in Welded Units
To Resist Positive and Negative Bending Moments and Shear

methods being used. Aside from the fact that the theory is being questioned, any inspector on the average concrete job knows that the steel when placed fails to meet the requirements even of present design practice. If the design is questionable and the construction is worse, the result must certainly be unsatisfactory.

Good shear reinforcing will never be provided so long as it is treated as a separate part of design and fabrication. The tension and shear steel must be fabricated and placed as a unit, but the unit cannot be the steel required for the entire beam. I have tried this, and so have several others, and it is not a success. The unit should be limited to one vertical plane.

In 1929, while at the plant of the Concrete Steel Company in Birmingham, Ala., I designed and had fabricated a series of units with the shear reinforcing inclined at 45 deg and welded to the horizontal steel. This year I have continued these practical tests. At neither time did I attempt to establish the fact that vertical stirrups are unsatisfactory; that has been done by many others. In these experiments we have assumed the following statements to be correct:

1. Continuity between tension and shear reinforcing is desired.
2. Shear reinforcing inclined at 45 deg is the best practical arrangement.
3. Welding is the only means of securing the desired results.

To state the problem concisely, we have determined what is considered to be a desirable system of shear reinforcing and whether it can be practicably obtained. In doing so we have attempted to answer the following questions:

1. What is the cost of the welding operations?
2. How much field time will be saved, and how much shop time will be added by shop welding?
3. What are the relative shear values of inclined bars anchored at top and bottom and of an equivalent area of vertical stirrups placed according to present practice?
4. Is it necessary to anchor the inclined bars on the compression side of the beam?
5. Are the welded units easily handled?

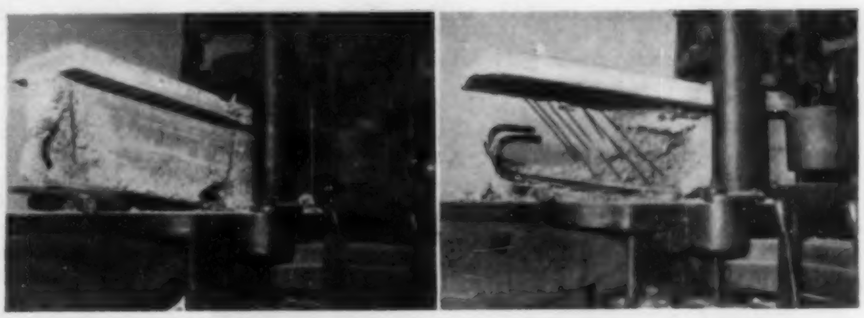
As soon as the project was begun, it became apparent that the design of the entire beam must be considered. It is customary to provide top steel at the supports by means of bent bars from the two adjacent spans. Our designs are now being made in the following manner: (1) find the steel area required at each critical section; (2) use straight bars to provide the required area; (3) connect the top steel at the supports to the bottom steel by welded inclined rods, in the amount and position required for shear; and (4) cut off the steel which is ordinarily bent up and bend the ends of this steel into large hooks or weld an inclined bar to the ends of the cut steel. A welded bar whose area is not less than one-fourth the area of the cut steel is the favored design. The general arrangement of bars is shown in Fig. 1.

In making the practical tests, the units first were welded and subjected to rough handling to see if they were strong enough to withstand ordinary job practice. No trouble with bending was encountered. Next, beams were made containing the welded units as reinforcement and tested to destruction. Similar beams reinforced with an "equivalent" area of vertical stirrups, were also tested in the same way. It is hoped that, as the number of tests increase, additional quantitative as well as qualitative information will be obtained on costs, placing, strength in shear, and the added factor of safety as a result of unit construction.

More tests are to be made and more specific information is to be obtained before a complete report can be made. At the present time, however, the following conclusions may be drawn:

1. The total cost of fabricating and placing will compare favorably with that of present methods.
2. The welded units are easier to handle than heavy bent bars and will not require more than two men to the unit for placing.
3. The steel can be placed more accurately than bent steel.
4. The total weight of steel required for a given condition is slightly less than when bent bars and vertical stirrups are employed.
5. The design is made easier and more accurately than when bent bars are used for top steel.

It is possible that some of these conclusions will be changed as a result of tests now in progress.



Test Beams with Welded Reinforcement Loaded to Failure
(*a*) Failure of Bond in Vertical Stirrups (*b*) Failure by Horizontal Shear

OUR READERS SAY—

In Comment on Papers, Society Affairs, and Related Professional Interests

Fire-Prevention Studies

To the Editor: In August 1932, Dallas, Tex., established a municipal position that may open a new field for the engineer. The title of this position is fire analyst and statistician. This new work brings technical training into the business of fire-loss control by means of increasing the efficiency of the fire-fighting branch of the city government. This adds greatly to the effectiveness of fire-prevention measures.

The position is under the supervision of the fire department, and the incumbent reports directly to the chief of the department. One of the first problems that arose in connection with the new position was the tabulation and analysis of fire losses for a number of years past. This study brought out clearly the location and cause of the large fire losses that Dallas has suffered in past years. In addition, a study has been made of the location of fire stations with the idea of eliminating those not absolutely essential. Another study of the major automotive equipment of the fire department was made in conjunction with the master mechanic. Dallas has an active Fire Prevention Council, which plans an enlarged program of activity based on suggestions developed from this work.

From my experience in this position, it appears that this is a type of work that engineers are suited both by training and education to do with credit.

A. F. Daniel, Assoc. M. Am. Soc. C.E.
Fire Analyst

Dallas, Tex.
April 21, 1933

Insurance Against Unemployment

To the Editor: In connection with the article by Mr. Friday, in the March issue, I am convinced that advance planning has not received the support from elected public officials that it deserves. Our present financial plight may be a cloud with a silver lining if it awakens a consciousness on the part of public administrators that works must be carried out intelligently. Apparently progress is being made in this direction. Not only should advance planning, in itself, be made the fundamental basis of our future fiscal progress, but it is even more important that a sound financial plan should accompany it. Our engineers must take a more active part in planning activities. They must, also, engage in the problem of financing public works.

It is amazing how little is known of the ordinary methods of financing and their related problems as they affect the general financial structure. This is the logical field for the engineer. The result of his studies, once he is driven into the work, will be of service to the community. Also, from a practical standpoint, the engineer will soon learn that this is the best form of insurance against his unemployment, and against that of hundreds of thousands of others dependent upon public works construction.

J. H. Neeson, M. Am. Soc. C.E.
Chief Engineer, Bureau of Engineering and Surveys

Philadelphia, Pa.
April 6, 1933

The Texas Form of Bond Workable and Working

To the Editor: According to some of the best legal minds in Texas, the form of fulfillment bond developed by the Texas Section, as described in the February number, does not impose a single obligation upon the surety that has not already been assumed by the contractor under the terms of his contract. To state, as did Mr. Bush, in the March issue, that such a bond is "unworkable" is equivalent to asserting that the contract it guarantees is also unworkable. More than 20 contracts, totaling over $1,500,000, have already been awarded under the Texas form of bond. No responsible contractor has yet failed to obtain this form of bond when awarded a contract. It has been revised to meet principal objections, and is not only workable but working.

The only way credit can be extended to irresponsible contractors is for the surety companies first to execute their bonds. When such credit is extended, the surety should be held responsible, in case the contractor defaults, for the same obligations imposed upon a responsible contractor.

Few sureties have ever been known to save a contractor. They seldom come into the picture until the contractor is completely exhausted. Sometimes they place crutches under the contractor to keep him from expiring before the work is completed, in order to avoid a technical default and thus enable them better to discount claims of unpaid creditors. This form of bond does not force the contractor or surety to pay a single item of expense that is not required by the contract, nor does it take away from the surety a single defense that is available to reputable contractors against unjust claims. It does attempt, by the common law of private contract, to nullify those technicalities by which the sureties are continually escaping liability. All just creditors should enjoy exactly the same protection under a public contract. Nothing could be more unethical and unfair to the reputable contractor than to permit his irresponsible competitor to escape full payment of just obligations through the assistance of the surety. Such a system is nothing more than a "racket" and is destroying the reputable contractor, as well as corporate surety underwriting.

If surety credit is extended only to responsible contractors, there will be no occasion for any increase in premium rate. Banks do not control the funds loaned to reputable contractors, and where such procedure is necessary, it is the best evidence that the contractor is not entitled to either bank credit or surety credit.

It is the opinion of leading engineers, architects, contractors, labor leaders, and equipment and material furnishers that, unless some relief is obtained from the abuses of the present system of underwriting, new methods of protecting owners and creditors on construction work must be developed. This is evidenced by the legislation that is now pending in various states. Some are proposing to carry their own surety risks. Indiana has eliminated bid bonds and requires the contractor to submit with his bid a performance bond completely executed. In Texas, owners are accepting Government securities in the amount of 15 per cent of the contract price, in lieu of a bond. Some have suggested that the surety co-sign the contract with the contractor.

Engineers should maintain the position of being the logical advisors to owners in construction matters, and should not allow the surety companies to dictate the form of surety coverage any more than they should allow the contractor to dictate the conditions of the contract. It is the trust of every public official to see that all public contracts are so awarded that every person furnishing any service shall be fully protected. This is also the moral duty of every private owner, and it is the professional duty of every engineer to see that the owner, as well as all others connected with any construction project, is fully protected. If the responsibility of the contractor is to be determined by furnishing a surety bond, such bond should unquestionably provide full coverage and guarantee complete fulfillment of all the terms of the contract. This is exactly what the Texas bond does, and no more. It is fair to every branch of the industry, will eliminate the unskilled and irresponsible bidder, and is unquestionably workable.

Texas Section, Committee on Contracts
Marvin C. Nichols, *Acting Chairman*
A. P. Rollins
W. W. McClendon
A. J. McKenzie

San Antonio, Tex.
May 10, 1933

Varying Silt Load in the Colorado River

To the Editor: Professor Chapman's article, in the February issue, and the partial quotations contained therein leave the impression that barren terrain, floods, and erosion are something new in the West. It is even stated (in quotation from Bulletin 675 of the U.S. Department of Agriculture), "Before the ranges had been overstocked and the ground cover impaired, erratic run-off and erosion were practically unknown."

In contrast to this statement, written in 1918, a few excerpts may be taken from a summary written 40 years previously, after ten years of detailed study by that master observer and pioneer scientific explorer of the West, Maj. James Wesley Powell (*Lands of the Arid Region*, 1878): "Between the lowlands on the one hand and the highlands on the other is found a great body of valley, mesa, hill, and low mountain lands. . . . Usually they bear a scanty growth of grasses. . . . The grasses grow to a great extent in scattered bunches. . . . In very low altitudes and latitudes the grasses are so scant as to be of no value. . . . Perennial or intermittent streams have carved deep waterways. . . . The streams have carved labyrinths of deep gorges. . . . After making all the deductions, there yet remain vast areas of valuable pasturage lands bearing nutritious but scanty grass. . . ." His full description of non-timbered, non-irrigable Western lands, the poorer of which remain in the unreserved public domain, emphasizes the scantiness of vegetation and the expanse of barren lands subject to intense erosion. It strongly suggests that much of the so-called overgrazing of today is merely a reflection of practically undisturbed natural conditions. In a region of light rainfall it is easy to predicate overgrazing even where there has been no grazing at all.

Francisco de Ulloa reported that in 1536 the waters of the Colorado River were "thick, black, and very muddy," a characterization quite as uninviting as the conditions that obtain today. Silt observations on the Colorado have been made at intervals for 30 years or more. Since 1925 systematic observations have been made at several points on the river and its principal tributaries. These testify to wide differences in silt load from year to year, varying rather closely with run-off, and suggesting that transporting power rather than availability of material governs its magnitude. No evidence of historical record or systematic observation suggests that the silt load is greater now than in the sixteenth century or that overgrazing on the open public domain has modified it in measurable degree.

F. H. Richardson, Assoc. M. Am. Soc. C.E.

Salt Lake City, Utah
April 17, 1933

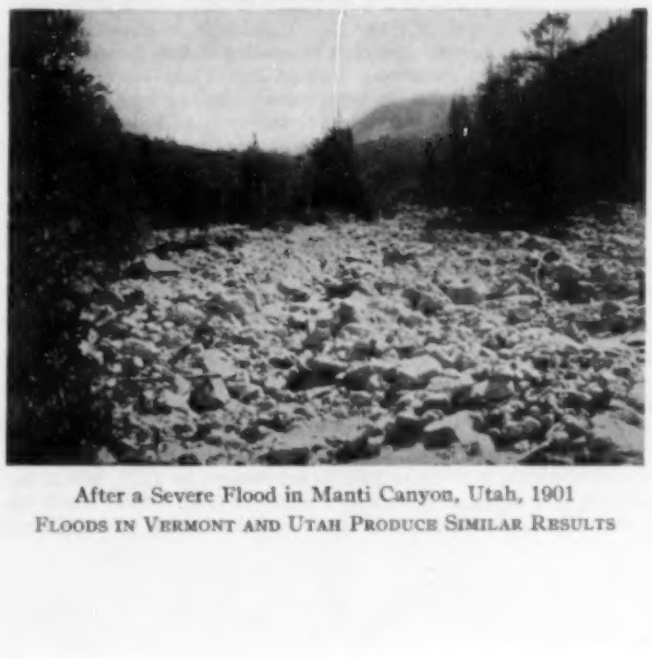
Grazing Control Stops No Floods

To the Editor: Exception may well be taken to some of the statements and inferences in Professor Chapman's article in Civil Engineering for February.

He says, without citation of authority, that Arrowrock Reservoir has already lost 6 per cent of its storage capacity by silting. It is a habit of reservoirs to accumulate silt. Professor Chapman neglects to state that wave action on steep borders of the reservoir has washed the rocks bare and transferred their cover below the water surface; that the South Fork and Middle Fork of the Boise River, two principal tributaries, are occupied by placer miners whose operations increase the silt accumulation of the reservoir; and that, although practically the entire watersheds of the North and Middle Forks, as well as the headwater region of the South Fork, have been for many years in a National Forest, which is regulated as to grazing by the Forest Service, they nevertheless contribute a considerable burden of silt to the reservoir accumulation. Is it reasonable to conclude that the entire 6 per cent (if such it be) loss of reservoir capacity, or any considerable part thereof, arises where, according to Professor Chapman, "there are hillsides which within the last decade have developed small gullies that honeycomb their surfaces in a most sinister manner," a "phenomenon" which some unknown person has "admitted" is caused by overgrazing?

According to the author, "In 1909, as a result of this protection [exclusion of stock from Manti Canyon under Forest Service regulation], the canyon entirely escaped the effect of a severe flood which ravaged Ephraim and Six Hill canyons, situated on each side of the protected area." According to Forsling (Technical Bulletin 220 of the U.S. Department of Agriculture), in 1903 Ephraim Canyon "was set aside within what is now the Manti National Forest, and grazing has been under regulation since shortly thereafter." Apparently grazing regulation, so effective on Manti Canyon, did not serve to save Ephraim Canyon from a "ravaging" flood. Floods on the Wasatch Plateau are caused by relatively intense local thunderstorms that strike first one and then another of the headwater regions of the multitude of canyons on its western slope. It is not surprising that in the same year two canyons, ten miles apart, were visited by such storms, and that a third canyon nearly midway between them was not visited by a shower of sufficient intensity to produce a considerable flood. It would be surprising, however, if the presence or absence of stock, or the presence or absence of the meager vegetation native to the region, had any effect whatever on the occurrence of such storms or a serious effect on the run-off from them. Rainfall records (Technical Bulletin 220 of the U.S. Department of Agriculture) at the headwaters of Ephraim Canyon disclose that there were four storms in the period from 1915 to 1921 that had rainfall of an inch

After a Ravaging Flood near Rutland, Vt., 1927



After a Severe Flood in Manti Canyon, Utah, 1901

Floods in Vermont and Utah Produce Similar Results

or more, and none of such magnitude from 1922 to 1929, inclusive. Are we to conclude that there was some relation of cause and effect in the fact that, in a typical local storm, 0.7 in. of rain fell in an area that had a vegetal cover of 16 per cent, while 1.43 in. fell on an area a thousand feet away that was 40 per cent covered?

The facts of much erosion and some overgrazing on the open public domain may be freely admitted. Downpours of rain were responsible for heavy erosion long before stock-raising was an important industry. If Professor Chapman has marshalled the best evidence to show that overgrazing has accelerated appreciably the rate of erosion, he has done much to disprove his thesis. Proof by misleading inferences without consideration of the dominant factors of influence is unconvincing.

BENJAMIN E. JONES, Assoc. M. Am. Soc. C.E.
Chief of the Power Division
U.S. Geological Survey

Washington, D.C.
April 28, 1933

Sudden Floods Initiate Erosion

TO THE EDITOR: In CIVIL ENGINEERING for February, Professor Chapman attributes widespread channel cutting in the arid Southwest to overgrazing, illustrating his theme by special reference to Chaco Canyon.

He gives a partial quotation from Dr. Kirk Bryan (*Science*, October 16, 1925), inferring that Dr. Bryan himself is a proponent of the overgrazing hypothesis, whereas he really aligns himself with Huntington, Gregory, and Visher in being favorably disposed toward a climatic hypothesis. In summary, Dr. Bryan concludes that initiation of arroyo cutting in southern Arizona can be confidently placed in the decade 1880 to 1890; in southern Utah apparently earlier, probably some time after 1860; and in north-central New Mexico still earlier, as the statements of early explorers indicate that the arroyos were already well formed at the time of the American conquest in 1846 and 1847, although the evidence is conflicting. He then reports the opinions of various writers as to the cause of erosion of the arroyos, and concludes that, "The present need is for more facts in order that one or another of the proposed theories may be established." The theory of the introduction of live stock as a cause of erosion is advanced by only one authority in six.

THE ARROYO IN CHACO VALLEY AT PUEBLO BONITO
The Valley Has Been Filled, Cut, and Refilled Time and Again

In August 1849, Simpson (Exec. Doc. 64, 31st Congress, 1st Session) traversed Chaco Canyon from its head to the ruins some miles below. In his sketchy description of the country, he mentions the canyon, itself evidence of former channel cutting, and speaks of the barrenness and lack of vegetation in terms that picture it quite as it is today. Contrary to Professor Chapman's statements as to sod, normal stream channel, and intact valley, Simpson does not state whether the Chaco was then flowing in an arroyo or a normal channel or whether the valley was then intact.

According to Dr. Bryan, Chaco Arroyo had attained a depth of 16 ft and a width of 60 ft at Pueblo del Arroyo in 1877, which increased to a depth of 30 ft and a width of from 200 to 300 ft by 1924, an indicated increase in cross section of about 6,500 sq ft in 47 years. This rate projected backward would indicate initial cutting at that point in 1870 or thereabouts. As Dr. Bryan states, "Floods merely deepen and widen the channels (arroyos) which continually grow headward into the undissected valley floors of headwater valleys and tributaries." While headward cutting may or may not have reached the section of the Chaco seen by Simpson in 1849, it was well started at Pueblo del Arroyo in 1877, as recorded by Jackson. Is it not likely that, in 1849 or earlier, the cutting was in full progress somewhere in the 80 or more miles between the head of Chaco Canyon and the San Juan River, even if not in the vicinity of Pueblo Bonito, and that the local cutting, now attributed by some to overgrazing, is in fact only the headward manifestation of an epicycle of alluvial erosion initiated on the Chaco long before the white man and his herds occupied the country? The arroyo in Chaco Valley is shown in the accompanying photograph.

Abnormal rainfall occurred at Fort Wingate, 50 miles southwest of Pueblo Bonito, during the period from 1867 to 1873, the recorded annual precipitation for this 7-year period being 70 per cent above the mean of the 46-year period beginning in 1864. Particularly significant is the record of 7.6 in. of rain in July (12.2 in. for July and August) 1867, and the record of 11.2 in. in February 1873. These climatic phenomena, favorable to the hypothesis of initiation of cutting by sudden floods, may not lightly be ignored in favor of the fanciful hypothesis of overgrazing as a cause of erosion activity.

C. E. DOBBIN
U.S. Geological Survey

Denver, Colo.
May 9, 1933

Four-Wheel Brakes Increase Road Capacity

DEAR SIR: The articles that have recently appeared on the subject of traffic control prompt me to submit a few queries. Many of the studies and counts on which the traffic capacities of highways have been based were made more than a few years ago. But we are using these figures for future as well as present estimates.

How much has the four-wheel brake, applied generally to automobiles of recent manufacture, contributed to reducing the spacing between vehicles on highways? Hence, by a curious reaction, how much has this superior device for retarding speed (and consequently for improving the control of the car) actually increased the traffic capacity of roadways? Also, to what extent will its more general use further increase that capacity?

Whether it is "simple curiosity" or an interest in "pure science" that prompts these queries, after some years of seeking, I have been unable to obtain any authentic data in answer to them.

W. W. CROSBY, M. Am. Soc. C.E.
Consulting Engineer

Coronado, Calif.
April 22, 1933

Traffic Delays Are Not Always Costly

TO THE EDITOR: The article on the "Cost of Traffic Delays," by Mr. Johannesson, in the March issue, brings up a subject upon which there have been two schools of thought. One group maintains that delays are costly, while the other states that such costs are visionary and that time saved in one place is wasted in another.

In my opinion both groups are right. There is no question but that time does have a value. Otherwise the automobile with its capacity for speed would not have displaced the horse or have assumed such an important place in our economic and transportation structures. In all analyses of the cost of delays, however, there is one assumption, made by inference, which explains the difference in opinion that now exists. This assumption is that the cost of a given group of traffic delays is directly proportional to the summation of the lengths of the separate delays. This is not true.

Consider this homely analogy. Suppose 10,000 people each have a thimbleful of sawdust. What can one of them do with his?

Practically nothing. But if each of the 10,000 gave his thimbleful to one individual, this person could make some use of it, for he would have an appreciable quantity.

The same is true of traffic delays. Suppose that a street intersection carries traffic in such a manner that every vehicle passing through it is delayed 15 sec. Also, assume that the average daily traffic at this point is 20,000 vehicles. The total delay is then 5,000 min. But all of this cannot be evaluated at a fixed rate, such as 1 cent per min, as it consists of many very small delays, each of which has no utility and consequently no value, since the whole cannot be greater than the sum of its parts.

There is, however, a possibility that some value can be attached to part of this delay. For example, it is possible that a delivery truck passes this intersection 20 times a day. Then it is delayed a total of 5 min. This extra time might permit of two additional deliveries, or at least would release the driver for 5 min of other labor. Thus, a number of small delays suffered by one vehicle can soon accumulate until the total amount of time lost becomes large enough to be utilized in some way and thus acquires a value.

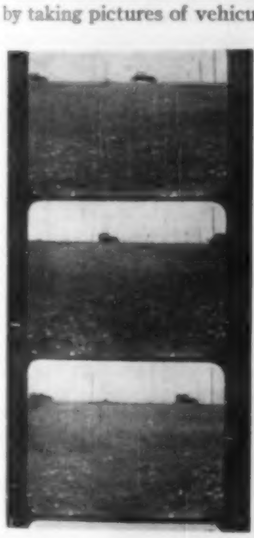
It is the value of such accumulated small delays to one vehicle—in its journey from home to work or vice versa, for example—that may furnish part of the economic justification for elevated highways and other costly structures. But the following facts should always be borne in mind: (1) the cost of delays does not vary directly as their total length; (2) some delays have value while others do not; and (3) the cost of a delay is dependent upon the use that can be made of the time saved if the delay were eliminated.

T. T. Wiley, Jun. Am. Soc. C.E.

Ottawa, Ill.
May 9, 1933

Vehicle Spacing by Movie Camera

Dear Sir: In his article on the "Cost of Traffic Delays," in the March number, Sigvald Johannesson makes the statement that, "Very little information appears to be available as to the minimum safe spacing of vehicles at various rates of speed. . . ." Confronted with this lack of information, I decided, last fall, that by taking pictures of vehicular traffic at short definite intervals of time, an instantaneous record of both the velocity and the spacing between vehicles could be made. With such a record, no matter what the actual velocity of the vehicles, the results could be tabulated at leisure. Since then enough pictures have been taken to indicate the possibilities of the procedure. However, it will be necessary to analyze a large number before reliable averages can be obtained. This work is now being carried out as a University of Michigan Fellowship project with the cooperation of the Michigan State Highway Department.



Sample Pictures Graduated in 5-Ft Intervals

A movie camera, using a standard 35-millimeter film and so constructed that individual exposures can be made, is used for the investigation. In order to keep a constant time interval between exposures, the camera is snapped by an electric motor driven by an automobile storage battery. By using a small rheostat, the time interval can be varied from one-half second to two and one-half seconds. The interval used depends upon the velocity of the vehicle and the field of view covered in each picture, for each vehicle must appear in at least two pictures.

The pictures are taken preferably at right angles to the roadway, so that the spacing of vehicles may be more accurately judged. Two poles set beside the road, or any two prominent objects a measured space apart, serve as a distance scale. With these two points, a scale with any required number of subdivisions can be constructed.

The accompanying illustration demonstrates how the pictures are studied. The vertical lines drawn on the film represent a scale with 5-ft intervals. The pictures are studied most easily when projected on a screen, which has the proper scale drawn upon it. In this manner, the distance between cars and the distance that the car has traveled between exposures are easily and rapidly found. The time interval for the pictures shown was eight-tenths of a second. The car at the left of the upper picture is 47 ft behind the car in front and has traveled 40 ft by the time it appears in the next picture, as can be seen by reading the scale, that is, by counting the 5-ft divisions.

Bruce D. Greenshields, Assoc. M. Am. Soc. C.E.

Ann Arbor, Mich.
May 1, 1933

Automobile Operating Costs

To the Editor: In these days when the highway industry, in general, is offering the public no reason for continued road construction except that it furnishes employment, a paper like Mr. Johannesson's "Cost of Traffic Delays," published in the March issue, is especially timely. The proper solution of the economic problems involved in highway improvement appears to depend, first, on the correct evaluation of the factors involved, and, second, on correct reasoning in the application of these values.

Although his conclusions, in general, are well considered and logical, I cannot quite follow him in the comparatively unimportant matter of the cost of delays in time items for passenger cars not used for business. He gives the annual cost of these items as $198 and then distributes this charge over a 24-hr day, giving a cost of about 0.03 cent per min. He then assumes that a delay of 1 min results in a cost of 0.03 cent to the owner.

Statistics of gasoline consumption indicate that the average car is driven about 7,000 miles a year. For ease in computation it may be assumed that the private passenger car travels 7,300 miles a year, or an average of 20 miles a day. This means that even at the slow average speed of 20 miles per hour, the car is used only one hour a day. If I interpret Mr. Johannesson's method correctly, this means that $^{23}/_{24}$, or about 96 per cent, of the cost of time items is wasted anyway, while the car is not in use. If 58 per cent of motor vehicles are private passenger cars, and about $190 is wasted annually on each one, the total waste is in the neighborhood of 14,000,000 × $190 = $2,660,000,000, a truly appalling figure! Perhaps this is the actual situation, or perhaps my interpretation is not correct; but it seems to me that these time items, for the private car, represent a "readiness to serve" charge and are entirely independent of the use of the car.

More important is his final sentence, "Generally speaking, an improvement is not economically justified unless its estimated cost is materially less than the estimated cost of the delays eliminated." I assume that he refers here only to improvements that do not involve decreases in operating costs, such as improvement of the surface or reduction of distance. In such cases, the reduction in operating costs may be considerably greater than the reduction in time costs and may frequently justify the improvement, regardless of savings in time.

I do not understand the statement: "It is conceivable that the time value of a vehicle might be greater than the cost of operation, but it cannot be considered to be less." On an annual basis, if the operating cost of the cars is even as low as 2 cents per mile, the cost of driving it 10,000 miles a year is greater than the time cost of $198. On a mileage basis, using the time cost given in Mr. Johannesson's article, it is nearly twice as large, even when the car is used for business and the time of the occupants is included.

These minor criticisms should not obscure the value of Mr. Johannesson's important contribution to a field that deserves much more study than it has so far received.

Roger L. Morrison, M. Am. Soc. C.E.
Professor of Highway Engineering and Highway Transport, University of Michigan

Ann Arbor, Mich.
April 24, 1933

Lock Construction in France

TO THE EDITOR: In connection with the drawing and description of Zonca's early navigation lock, in the March issue, I was interested to note the likeness between that lock and the construction of the locks of the ancient Languedoc Canal, or the Canal du Midi, in France. The accompanying photograph shows the elliptical shape of the lock chamber in this canal, which is located at Carcassonne.

This Canal du Midi was probably designed toward the middle of the seventeenth century, for it was completed in 1681. It is quite an extensive engineering work, nearly 150 miles long, with 119 locks, and a maximum elevation above sea level of 620 ft. The canal, which joins the Bay of Biscay and the Mediterranean, is in regular use today. Its designer was Baron Paul Riquet de Bonrepos.

There would seem to be a very definite connection between the actual design of the locks of this ancient work and the project shown in the old sketch, and it would be interesting to know if the still older Canal of Briare, commenced in 1605 and finished in 1642, has the same type of lock chamber as the Canal du Midi.

LOCK IN CANAL DU MIDI AT CARCASSONNE, FRANCE

Indeed, in view of the dates and existing evidence it seems likely that the sketch in the old book of Zonca was taken from the actual plans of the Briare Canal.

GEORGE S. BINCKLEY, M. Am. Soc. C.E.
Consulting Hydraulic Engineer

Los Angeles, Calif.
May 5, 1933

Mass Curve in Solving Storage Reservoir Problem

DEAR SIR: The use of the mass curve in the solution of the storage reservoir problem, as described by H. K. Barrows in the April issue, seems to me to be preferable, at least from the standpoint of simplicity, to any of the other methods available for the same purpose. Those developed by the Miami Conservancy District and described in their Technical Reports, Part VII, are cumbersome by comparison. This method has been in use at Purdue University since 1929 and has been presented to the students. We would have published it had we not felt that the essence of the method is given in *Der Wasserbau*, a two-volume treatise by Armin Schoklitsch, published in 1930. Diagrams similar to those given by Professor Barrows, are shown on page 65 of this work.

It is true that the slopes of the "spillway flow" curves are given for particular heads and not for the averages of heads in a particular range of elevations. The use by Professor Barrows of a discharge rate based upon an average of heads for a particular range of elevations instead of a discharge based upon the initial or final head in that range, is clearly an improvement, although the true mean discharge for the time interval under consideration may be significantly different from that given by either of the methods just described.

As pointed out by Schoklitsch, such errors become small if the chosen increment of head, or of discharge rate, is made very small. He utilizes an auxiliary curve whose abscissa is reservoir volume and whose ordinate is discharge rate. From this curve he obtains, by purely graphical methods, the slope for any discharge or corresponding reservoir elevation. Thus, he may rapidly solve any problem by purely graphical methods, even though very small steps or increments of head are taken. It is just as convenient to utilize average discharges as terminal discharges by this method, if that seems desirable.

Professor Barrows has performed a real service in making this method available for American engineers. Apparently it has been developed independently by several workers and has until now been published only in German.

W. E. HOWLAND, Assoc. M. Am. Soc. C.E.
Assistant Professor of Civil Engineering
Purdue University

La Fayette, Ind.
May 4, 1933

Consumption, Not Production, Needs Stimulation

DEAR SIR: In his article on "International Relations," in the March issue, Fred I. Kent has given a most interesting commentary on a series of post-War events. Among these was the support of German labor in idleness by means of funds borrowed by the national government. All students of economics will agree that such practice is unsound.

For the United States, Mr. Kent proposes to restore employment "to a sound basis even though the process may at times require the temporary support of government." His tactical plan to achieve that objective is for the Federal Government, through the Reconstruction Finance Corporation, to insure industries against loss, if industry will enter into normal production, say that of 1927, and employ a substantial number of the idle.

It is a known fact that those involved in industry, from the producer of raw materials to the retailer and consumer, have large matured or maturing debts. The net result of such an operation would be Government absorption of private debt, and to some extent the absorption of private charity. The credits advanced by the Government, at least to the extent of the unrecoverable guarantee, would have to liquidate most of the loans outstanding. The labor charge would be part of the manufacturers' unsecured debt.

The first use of wages will be to settle back bills. The lag between wage payments and consumer activity would be from 30 days to one year. Meanwhile production would merely add to the surplus. We want consuming power but not producing power at work. We have suffered too much from a flood of commodities; and no flood was ever brought under control by increasing the flow at headwaters. Commodity overflows can be relieved only by broadening the outlet through mass consumption. The first step in doing this is to get funds, or goods, or both, into the hands of the reemployed. Consumer activity, but not producer activity, is required first, and now.

With all due respect, it is suggested that the plan proposed is of the general type produced by the past activities of the Reconstruction Finance Corporation, whereby banks and railroads received funds to maintain financial structures, without bringing any help to the unemployment situation. The Reconstruction Finance Corporation is a financial institution controlled by highly skilled persons with lifelong training in financing the solvent. Mr. Kent has proposed an industrial credit plan that no bank would, for one moment, support with its own funds. Banking solves all problems through its one instrument of money credit. Failing to do this, it does not find a solution. If the Reconstruction Finance Corporation is to be of any help in meeting the combined problems of commodity surplus and unemployment, its whole outlook must change.

Mr. Kent's objective will be universally approved, but there are other ways of achieving it at a much lower cost, in much less time, and with greater benefit, now and in the future.

VERNE LE ROY HAVENS, M. Am. Soc. C.E.
Consulting Engineer

New York, N.Y.
April 22, 1933

Century of Progress Exposition, Easily Accessible by Bus from the Palmer House

Sixty-Third Annual Convention

Palmer House, Chicago, Ill.—June 27–30, 1933—Program of Sessions, Entertainment, and Trips

Opening Sessions—General Technical Meeting

TUESDAY—June 27, 1933—Morning

9:00 **Registration**

General Meeting

RED LACQUER ROOM

10:00 **Sixty-Third Annual Convention called to order by**

W. W. DeBerard, *M. Am. Soc. C.E., President, Illinois Section; Associate Editor, "Engineering News-Record,"* Chicago, Ill.

10:10 **Address of Welcome**

His Honor, Edward J. Kelly, *M. Am. Soc. C.E., Mayor of the City of Chicago.*

10:30 **Response**

Alonzo J. Hammond, *President Am. Soc. C.E., Consulting Engineer,* Chicago, Ill.

10:40 **Annual Address**

Alonzo J. Hammond, *President Am. Soc. C.E., Consulting Engineer,* Chicago, Ill.

11:30 **Introduction of Distinguished Guests**

12:00 **Presentation of Junior Membership Awards**

12:15 **Business Meeting**

12:30 **Members' Luncheon**

In Empire Room. No luncheon tickets. Members to order and pay for luncheon individually.

TUESDAY—June 27, 1933—Afternoon

General Technical Meeting

Symposium on Tax Reduction

Arranged under the auspices of the Engineering Economics and Finance Devision

RED LACQUER ROOM

Round-Table Conference on the Problem of Federal, State, and Municipal Tax Reduction

2:15 **Federal Tax Reduction**

E. P. Goodrich, *M. Am. Soc. C.E., Consulting Engineer,* New York, N.Y.

2:45 **State Tax Reduction**

Frank Bane, *Esq., Director, American Public Welfare Association,* Chicago, Ill.

Luther Gulick, *Esq., Director, Institute of Public Administration,* New York, N.Y.

3:40 **Municipal Tax Reduction**

Louis Brownlow, *Esq., Director, Public Administration Clearing House,* Chicago, Ill.

TUESDAY—June 27, 1933—Evening

Industrial and Engineering Progress

GRAND BALL ROOM

8:30 **Joint Session**

Under auspices of Section M, American Association for the Advancement of Science. Addresses on industrial and engineering developments of the century.

Special Excursion Rates to Chicago Available. Consult Nearest Ticket Agent Early.

Engineers' Day at Century of Progress Exposition

WEDNESDAY—June 28, 1933—All Day

Morning

Award of Guggenheim Medal

Members, Ladies, and Guests of the 15 participating Societies will assemble at 10:30 a.m. in the stadium at Soldiers Field for the presentation of the Daniel Guggenheim Medal to Juan de la Cierva, the inventor of the autogyro. It is expected that Mr. Cierva will arrive at the Stadium in a Pitcairn autogyro.

The Western Society of Engineers, which is acting as general host to visiting engineers during Engineers' Week, will make use of this occasion to welcome the engineers to Chicago.

Afternoon

Following the ceremonies at the stadium, the group will have luncheon on the Exposition grounds, after which the afternoon will be spent in an inspection of the attractions and engineering works at the fair.

At the Century of Progress Exposition concrete expression is given to the spirit of man's achievements during the past 100 years. Its international character, the fantastic and daring design of the buildings, their bizarre colorings, the unique effects obtained by night lighting, the landscaping, and the scientific exhibits showing the advances made in transportation, communication, and the generation and use of electricity—to mention but a few—will all attract engineers from the world over. One of the spectacular designs from an engineering standpoint is the Skyway, hung between two steel towers 625 ft high and a third of a mile apart. Rocket cars operating on cables between the towers afford passengers a striking vista of the fair and the city.

Court of the Hall of Science

Evening

7:00 Joint Engineering Dinner at Stevens Hotel

Tickets for the dinner and evening's entertainment are $3.00 each.

Electrical Building—An Architectural Phantasy

Travel and Transport Building and Dome

Entertainment for the Ladies

TUESDAY—June 27, 1933

Morning

Registration—Fourth Floor

At the ladies headquarters on the fourth floor of the Palmer House, information will be available on points of interest in Chicago, with fares, distances, maps, etc. General information on the Century of Progress Exposition will also be available.

Afternoon

12:30 Invitation Luncheon

For ladies of Members only. Rooms 10 and 11, on third floor of the Palmer House.

Following the luncheon, there will be a lecture at 2:00 p.m. on the Century of Progress Exposition by Miss Helen Bennett.

3:30 Sightseeing

In the immediate vicinity of the Palmer House. If desired, groups may be escorted by members of the Ladies Committee.

WEDNESDAY—June 28, 1933—All Day

Plans have been made for the ladies to spend the entire day at the Exposition and to have luncheon on the fair grounds.

Tickets for general admission to the fair and other tickets will be available at the Registration Desk at the following prices:

Bus fare from hotel to fair	10 cents
General admission to fair	50 cents
Children under 12, admission	25 cents

For a small fee, children may be cared for on Enchanted Isle.

THURSDAY—June 29, 1933—Morning

9:00 Assembly at Palmer House

Individual groups under the guidance of members of the Ladies Committee will visit the Aquarium (no cost) and the Field Museum (no cost) and have luncheon at restaurants in the Century of Progress Exposition.

Afternoon

2:30 Visit and Lecture at Planetarium

Tickets are 25 cents each.

Friday—June 30, 1933

Morning

10:00 Arrangements have been made for the ladies to visit the following places of interest: Marshall Field's, the University of Chicago, International House, and the Museum of Science and Industry.

Sessions of Technical Divisions—Two Full Days

THURSDAY—June 29, 1933—Morning

Power Division

Jointly with
Hydraulics Division of American
Society of Mechanical Engineers

ROOM 14

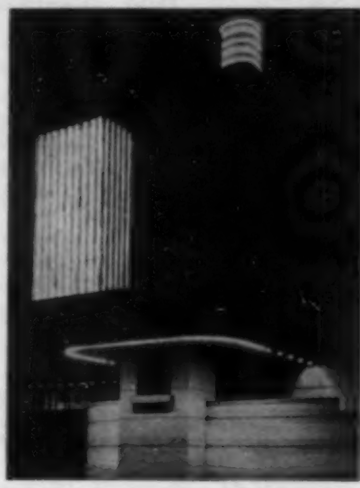
9:00 **Flow of Water Around Bends in Open and Closed Channels**

David L. Yarnell, *M. Am. Soc. C.E., Senior Drainage Engineer, Bureau of Agricultural Engineering, U.S. Department of Agriculture*, Iowa City, Iowa; and

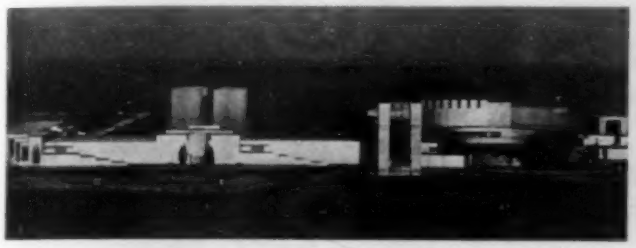
Floyd A. Nagler, *M. Am. Soc. C.E., Professor of Hydraulic Engineering, University of Iowa*, Iowa City, Iowa.

10:00 **Discussion**

10:30 **Report of Power Division's Committee on Legislation Respecting Safety of Dams**



Neon Lights on Carillon Tower



Halls of Science, Electricity, and Communication

Night Along the Chicago River

R. A. Monroe, *M. Am. Soc. C.E., Civil and Hydraulic Engineer, Aluminum Company of America*, Pittsburgh, Pa.

11:00 **Discussion**

Structural Division

Jointly with Applied Mechanics Division
of American Society of Mechanical Engineers

ROOM 404

9:30 **The Rational Design of Steel Columns**

D. H. Young, *Jun. Am. Soc. C.E., Instructor, Engineering Mechanics, University of Michigan*, Ann Arbor, Mich.

10:00 **Discussion opened by**

F. E. Turneaure, *M. Am. Soc. C.E., Dean, College of Mechanics and Engineering, University of Wisconsin*, Madison, Wis.

S. Timoshenko, *Esq., Professor of Engineering Mechanics, University of Michigan*, Ann Arbor, Mich.

H. M. Westergaard, *M. Am. Soc. C.E., Professor, Theoretical and Applied Mechanics, University of Illinois*, Urbana, Ill.

M. O. Withey, *Professor of Mechanics, University of Wisconsin*, Madison, Wis.

11:00 **Stability of the Web of Plate Girders**

S. Timoshenko, *Esq., Professor of Engineering Mechanics, University of Michigan*, Ann Arbor, Mich.

11:30 **Discussion opened by**

Otis E. Hovey, *M. Am. Soc. C.E., Consulting Engineer, American Bridge Company*, New York, N.Y.

Jonathan Jones, *M. Am. Soc. C.E., Chief Engineer, McClintic-Marshall Corporation*, Bethlehem, Pa.

L. H. Donnell, *Esq., Research Engineer, California Institute of Technology*, Pasadena, Calif.

H. M. Westergaard, *M. Am. Soc. C.E., Professor, Theoretical and Applied Mechanics, University of Illinois*, Urbana, Ill.

12:00 **Stability of Thin Walled Tubes Under Torsion**

L. H. Donnell, *Esq., Research Engineer, California Institute of Technology*, Pasadena, Calif.

12:30 **Discussion opened by**

Dr. Theodore von Karman, *Director, Guggenheim Aeronautical Laboratories, California Institute of Technology*, Pasadena, Calif.

S. Timoshenko, *Esq., Professor of Engineering Mechanics, University of Michigan*, Ann Arbor, Mich.

A. V. Karpov, *M. Am. Soc. C.E., Designing Engineer, Hydraulic Department, Aluminum Company of America*, Pittsburgh, Pa.

Waterways Division

CLUB DINING ROOM

9:30 **Chicago Terminus of the Lakes-to-Gulf Waterway**

Daniel I. Sultan, *Esq., Lieutenant-Colonel, District Engineer, U.S. Engineer Office*, Chicago, Ill.

10:30 **Discussion opened by**

J. W. Woermann, *M. Am. Soc. C.E., Senior Civil Engineer, U.S. Engineer Office*, Chicago, Ill.

L. D. Cornish, *M. Am. Soc. C.E., Chief Engineer, Division of Waterways, State of Illinois*, Chicago, Ill.

Rufus W. Putnam, *M. Am. Soc. C.E., President, The Maritime Engineering Corporation*, Chicago, Ill.

M. W. Oettershagen, *Esq., Harbormaster, Navy Pier*, Chicago, Ill.

Construction Division

RED LACQUER ROOM

A Century of Progress in Construction Methods

9:30 **The Construction Engineer—The Centenarian**

W. C. Huntington, *M. Am. Soc. C.E., Professor of Civil Engineering and Head of Department, University of Illinois*, Urbana, Ill.

9:50 **A Century of Progress in the Construction of Transportation Facilities**

F. G. Jonah, *Vice-President Am. Soc. C.E., Chief Engineer, Frisco Lines*, St. Louis, Mo.

10:10 A Century of Progress in the Development of Bridge Construction

O. H. AMMANN, *M. Am. Soc. C.E., Chief Engineer, The Port of New York Authority,* New York, N.Y.

10:30 A Century of Progress in Methods of Constructing Municipal Facilities

SAMUEL A. GREELEY, *M. Am. Soc. C.E., Pearse, Greeley and Hansen,* Chicago, Ill.

10:50 A Century of Progress in Evolution of Methods in the Construction of Reclamation Projects

ELWOOD MEAD, *M. Am. Soc. C.E., Commissioner of Reclamation, Department of the Interior,* Washington, D.C.

11:10 Comparison of Methods in the Construction of Industrial Buildings Covering the Century

T. L. CONDRON, *M. Am. Soc. C.E., Consulting Engineer,* Chicago, Ill.

11:30 Discussion

12:30 Luncheon in honor of Maj.-Gen. Lytle Brown, Chief of Engineers, U.S.A.

To be held jointly with the Society of American Military Engineers; Construction Division, American Society of Civil Engineers; and the American Society of Mechanical Engineers.

Tickets $1.25 each. Grand Ball Room of the Palmer House.

Tickets may be procured either through advance ticket order (see page 12) or through H. A. Roe, Treasurer, Chicago Section, Society of American Military Engineers, 438 South Clinton Street, Chicago, Ill.

THURSDAY—June 29, 1933—Afternoon

POWER DIVISION

JOINTLY WITH
AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS AND HYDRAULICS DIVISION OF AMERICAN SOCIETY OF MECHANICAL ENGINEERS

GRAND BALL ROOM

2:15 Résumé of the Engineering Reports on the St. Lawrence Power Development

DANIEL W. MEAD, *Hon. M. Am. Soc. C.E., Professor, Hydraulic and Sanitary Engineering, University of Wisconsin; Consulting Engineer,* Madison, Wis.

3:15 Discussion opened by

THOMAS H. HOGG, *M. Am. Soc. C.E., Chief Hydraulic Engineer, Hydro-Electric Power Commission of Ontario,* Toronto 2, Ont., Canada.

3:20 Discussion opened by

R. H. SHERLOCK, *Assoc. M. Am. Soc. C.E., Associate Professor, Civil Engineering, University of Michigan,* Ann Arbor, Mich.

ALBERT SMITH, *M. Am. Soc. C.E., Smith and Brown Engineers, Inc.,* Chicago, Ill.

C. R. YOUNG, *M. Am. Soc. C.E., Professor of Civil Engineering, University of Toronto,* Toronto, Ont., Canada.

THURSDAY—June 29, 1933—7:30 p.m.

BOAT TRIP ON LAKE MICHIGAN

Jointly with members, ladies, and guests of the American Society of Mechanical Engineers and the American Society for Testing Materials. The boat, S.S. President Roosevelt, will leave promptly at 7:30 from Michigan Avenue Bridge. An exceptional opportunity will be afforded to view the illumination of the Century of Progress Exposition.

Tickets for the trip and evening's entertainment are $1.00 each. The number of tickets is limited to 1,800. For those who wish to dine on board the boat, a specially prepared box luncheon will be furnished. Tickets for the trip, including luncheon, are $1.50 each.

STRUCTURAL DIVISION

JOINTLY WITH
APPLIED MECHANICS DIVISION OF AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ROOM 404

Experimental Research in Structural Engineering

2:15 Laboratory Tests of Multiple-Span Reinforced Concrete Arches

W. M. WILSON, *M. Am. Soc. C.E., Research Professor, Structural Engineering, University of Illinois,* Urbana, Ill.

2:35 Discussion opened by

HARDY CROSS, *M. Am. Soc. C.E., Professor, Structural Engineering, University of Illinois,* Urbana, Ill.

SEARCY B. SLACK, *M. Am. Soc. C.E., Bridge Engineer, State Highway Board,* Atlanta, Ga.

GEORGE E. BEGGS, *M. Am. Soc. C.E., Professor, Civil Engineering, Princeton University,* Princeton, N.J.

3:00 Wind Pressure on Buildings

Dr.Eng. O. FLACHSBART, *Lehrstule für Mechanik, Technische Hochschule,* Hannover, Germany.

3:40 Tests of Split-H End Connections for Wind Girders

W. C. HUNTINGTON, *M. Am. Soc. C.E., Professor of Civil Engineering and Head of Department, University of Illinois,* Urbana, Ill.

4:00 Discussion opened by

ALBERT F. REICHMANN, *M. Am. Soc. C.E., Assistant Chief Engineer, American Bridge Company,* Chicago, Ill.

ALBERT SMITH, *M. Am. Soc. C.E., Smith and Brown Engineers, Inc.,* Chicago, Ill.

C. R. YOUNG, *M. Am. Soc. C.E., Professor of Civil Engineering, University of Toronto,* Toronto, Ont., Canada.

CONSTRUCTION DIVISION

RED LACQUER ROOM

Symposium on "A Century of Progress in Construction Methods" (*continued*)

2:15 A Century of Progress in Methods of Construction of National Defense Facilities on Water

R. E. BAKENHUS, *M. Am. Soc. C.E., Rear-Admiral, Civil Engineer Corps, U.S. Navy, 3d Naval District Headquarters,* New York, N.Y.

2:35 National Defense Facilities on Land

LYTLE BROWN, *M. Am. Soc. C.E., Major-General, Chief of Engineers, U.S. Army.,* Washington, D.C.

2:55 Review of Methods in the Construction of Water Terminals Over the Past Century

WALTER J. CAHILL, *M. Am. Soc. C.E., Vice-President, Great Lakes Dredge and Dock Company,* Chicago, Ill.

3:15 A Century of Construction Machinery

F. C. RUHLOFF, *Esq., Sales Engineer, Bucyrus-Erie Company,* South Milwaukee, Wis.

3:35 **Sound Control in the Buildings of the Future**

PAUL E. SABINE, *Esq., Department of Acoustics, Riverbank Laboratories,* Geneva, Ill.

3:55 **Discussion**

HIGHWAY DIVISION

CLUB DINING ROOM

2:15 **Highway Improvement—How to Keep It Sold to the Public**

E. J. MEHREN, *M. Am. Soc. C.E., President, Portland Cement Association,* Chicago, Ill.

2:45 **The Time Element in Highway Traffic Movement**

E. W. JAMES, *M. Am. Soc. C.E., Chief, Division of Design, Bureau of Public Roads,* Washington, D.C.; and MILLER MCCLINTOCK, *Esq., Director, Albert Russel Erskine Bureau for Street Traffic Research, Harvard University,* Cambridge, Mass.

3:15 **Discussion**

SURVEYING AND MAPPING DIVISION

PRIVATE DINING ROOM 14

2:15 **City Surveys—Past, Present, and Future**

G. D. WHITMORE, *Assoc. M. Am. Soc. C.E., Vice-President and Assistant Chief Engineer, R. H. Randall and Company, Inc.,* Toledo, Ohio.

2:45 **Discussion**

3:15 **One Hundred Years of Control Surveys**

WILLIAM BOWIE, *M. Am. Soc. C.E., Chief, Division of Geodesy, U.S. Coast and Geodetic Survey,* Washington, D.C.

3:45 **Discussion**

FRIDAY—June 30, 1933—Morning

STRUCTURAL DIVISION

JOINTLY WITH APPLIED MECHANICS DIVISION OF AMERICAN SOCIETY OF MECHANICAL ENGINEERS

ROOM 404

Dynamic Problems

9:30 **Impact Effect on Bridges**

DR. R. BERNHARD, *German Railway Systems,* Berlin, Germany.

10:00 **Graphostatics of Stress Functions**

H. M. WESTERGAARD, *M. Am. Soc. C.E., Professor of Theoretical and Applied Mechanics, University of Illinois,* Urbana, Ill.

Discussion opened by

S. C. HOLLISTER, *Assoc. M. Am. Soc. C.E., Professor of Structural Engineering, and Assistant Director, Materials Testing Laboratory, Purdue University,* La Fayette, Ind.

DR. A. NADAI, *Research Laboratories, Westinghouse Electric and Manufacturing Company and University of Pittsburgh,* Pittsburgh, Pa.

11:00 **The Amplitudes of Non-Harmonic Vibrations**

J. P. DEN HARTOG, *Esq., Assistant Professor, Harvard University,* Cambridge, Mass.

Discussion opened by

L. S. JACOBSON, *Esq., Professor, Stanford University,* Stanford University, Calif.

F. M. LEWIS, *Esq., Professor of Engineering, Webb Institute of Naval Architecture; Consulting Engineer,* New York, N.Y.

M. STONE, *Esq., Power Engineer, Westinghouse Electric and Manufacturing Company.*

SANITARY ENGINEERING DIVISION

RED LACQUER ROOM

9:30 **Present Status of Sewage Treatment at Chicago, and Other Sewage Treatment Projects in Relation to the Illinois River**

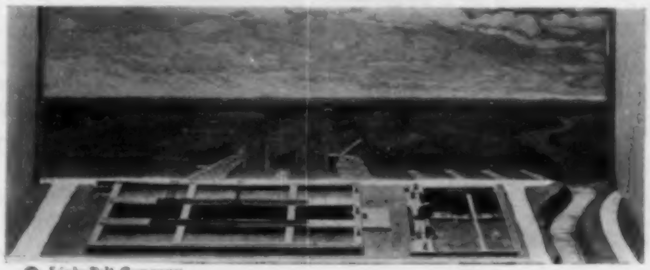
LANGDON PEARSE, *M. Am. Soc. C.E., Sanitary Engineer, The Sanitary District of Chicago,* Chicago, Ill.

10:00 **Discussion opened by**

H. P. EDDY, *M. Am. Soc. C.E., Consulting Engineer,* Boston, Mass.

J. K. HOSKINS, *Esq., U.S. Public Health Service,* Cincinnati, Ohio.

H. W. STREETER, *M. Am. Soc. C.E., Sanitary Engineer, U.S. Public Health Service,* Cincinnati, Ohio.



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DIORAMA OF SEWAGE DISPOSAL PLANT

Typical of Many Century of Progress Exhibits

10:20 **Stream Cleansing—The Sangamon River**

W. D. HATFIELD, *Assoc. M. Am. Soc. C.E., Superintendent, Sewage Disposal Plant,* Decatur, Ill.

10:50 **Discussion opened by**

EDWARD BARTOW, *M. Am. Soc. C.E., Professor and Head, Department of Chemistry and Chemical Engineering, University of Iowa,* Iowa City, Iowa.

S. A. GREELEY, *M. Am. Soc. C.E., Pearse, Greeley and Hansen,* Chicago, Ill.

11:10 **Stream Cleansing**

ALMON L. FALES, *M. Am. Soc. C.E., Consulting Engineer, Metcalf and Eddy,* Boston, Mass.

11:40 **Discussion opened by**

F. W. MOHLMAN, *Esq., Chief Chemist, Sanitary District of Chicago,* Chicago, Ill.

W. R. COPELAND, *Affiliate Am. Soc. C.E., Sanitary Engineer, State Water Commission,* Hartford, Conn.

POWER DIVISION

JOINTLY WITH HYDRAULICS DIVISION OF AMERICAN SOCIETY OF MECHANICAL ENGINEERS

PRIVATE DINING ROOM 14

Symposium on "Water Hammer"

9:30 **Committee Report Reviewing the Present Status of Water Hammer Theory**

9:45 **A Simplified Derivation of Water Hammer Formula**

LEWIS F. MOODY, *Esq., Professor, Hydraulic Engineering, Princeton University; Consulting Engineer, Cramp Morris Industrials, Inc.,* Philadelphia, Pa.

10:00 **The Effect of Surge Tanks and Surge Tank Risers on Water Hammer Computations**

EUGENE E. HALMOS, *M. Am. Soc. C.E., Chief Engineer, Parklap Construction Corporation,* New York, N.Y.

10:15 **High Head Penstock Design**

A. W. K. BILLINGS, *M. Am. Soc. C.E., Vice-President, Brasilian Traction, Light, and Power Company, Ltd.*, Rio de Janeiro, Brazil.

O. H. DODKIN and F. KNAPP, *Esquires, Hydraulic Engineers, The Sao Paulo Tramway Light and Power Company, Ltd.*, Sao Paulo, Brazil; and

ADOLPHO SANTOS, JR., *Jun. Am. Soc. C.E., Assistant Engineer, The Sao Paulo Tramway Light and Power Company, Ltd.*, Sao Paulo, Brazil.

10:30 **Influence of Water Hammer on Design of High-Head Penstocks at the Drum Plant and the Tiger Creek Plant**

WALTER DREYER, *M. Am. Soc. C.E., Assistant Chief, Division of Civil Engineering, Pacific Gas and Electric Company*, San Francisco Calif.

10:45 **Computation of Water Hammer Pressures in Compound Pipes**

R. E. GLOVER, *Esq., Engineer, U.S. Bureau of Reclamation*, Denver, Colo.

11:00 **Surge Control in Centrifugal Pump Discharge Lines**

RAY S. QUICK, *M. Am. Soc. C.E., Chief Engineer, Pelton Wheel Company*, San Francisco, Calif.

11:15 **Water Hammer Tests in Croton Lake Pumping Plant**

S. LOGAN KERR, *Assoc. M. Am. Soc. C.E., Water Works Engineer, Baldwin-Southwark Corporation*, Philadelphia, Pa.

11:00 **Discussion**

MICHIGAN AVENUE BRIDGE, CHICAGO

CITY PLANNING DIVISION

CLUB DINING ROOM

9:30 **Preparedness for Slum Clearance**

JOHN H. MILLAR, *Esq., Editor and Publisher, Millar's Housing Letter*, Chicago, Ill.

10:00 **Discussion opened by**

FREDERICK L. ACKERMAN, *Esq., Architect*, New York.

WILBUR J. WATSON, *M. Am. Soc. C.E., D.Eng., Architect and Engineer*, Cleveland, Ohio; and HOWARD W. GREEN, *Assoc. M. Am. Soc. C.E.*, Cleveland, Ohio.

10:45 **Value of Planned City Development**

HUGH E. YOUNG, *M. Am. Soc. C.E., Engineer, Chicago Plan Commission.*

11:15 **Discussion opened by**

U. N. ARTHUR, *M. Am. Soc. C.E., Chief Engineer, Department of City Planning, City of Pittsburgh.*

SURVEYING AND MAPPING DIVISION

ROOM 405

9:30 **Land Surveying—Its Foundation and Superstructure**

M. L. GREELEY, *Esq., President, Greeley, Howard and Norlin Company*, Chicago, Ill.

10:00 **Discussion**

10:30 **The Land Surveyor's Starting Point**

W. D. JONES, *Esq., Civil Engineer and Surveyor*, Chicago, Ill.

ROSENWALD MUSEUM, JACKSON PARK

SOUTH DAMEN AVENUE BRIDGE, CHICAGO

FRIDAY—June 30, 1933—Afternoon

POWER DIVISION

JOINTLY WITH HYDRAULICS DIVISION
OF AMERICAN SOCIETY OF MECHANICAL ENGINEERS
PRIVATE DINING ROOM 14

2:15 **Discussion of Symposium on "Water Hammer"**

STRUCTURAL DIVISION

JOINTLY WITH APPLIED MECHANICS DIVISION
OF AMERICAN SOCIETY OF MECHANICAL ENGINEERS
ROOM 404

2:15 **A Generalized Deflection Theory for Suspension Bridges Including the Analysis of Continuous Spans**

D. B. STEINMAN, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y.

2:45 **Discussion opened by**

S. TIMOSHENKO, *Professor of Engineering Mechanics, University of Michigan*, Ann Arbor, Mich.

A. H. BAKER, *Assoc. M. Am. Soc. C.E., Assistant Engineer, Research and Tests Section, Design Division, The Port of New York Authority*, New York, N.Y.

LEON S. MOISSEIFF, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y.

3:05 **A Suspension Stiffening Truss of Tension Members as Developed for the Chicago Skyway**

William G. Grove, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y.

3:35 **Discussion opened by**

C. M. Jones, *Esq., Assistant Chief Engineer, John A. Roebling's Sons Company*, Trenton, N.J.

I. F. Stern, *M. Am. Soc. C.E., Consulting Engineer*, Chicago, Ill.

R. Boblow, *Assoc. M. Am. Soc. C.E., Engineer, Robinson and Steinman*, New York, N.Y.

E. T. Blix, *Esq., Chief Engineer, Mississippi Valley Structural Steel Company*, Melrose Park, Ill.

George E. Beggs, *M. Am. Soc. C.E., Professor of Civil Engineering, Princeton University*, Princeton, N.J.

3:55 **The Theory of the Suspension Bridge**

A. A. Jakkula, *Jun. Am. Soc. C.E., Instructor, Department of Civil Engineering, University of Michigan*, Ann Arbor, Mich.

4:25 **Discussion opened by**

D. B. Steinman, *M. Am. Soc. C.E., Consulting Engineer*, New York, N.Y.

J. H. Cissel, *M. Am. Soc. C.E., Professor of Structural Engineering, University of Michigan*, Ann Arbor, Mich.

J. I. Parcel, *M. Am. Soc. C.E., Professor of Structural Engineering, University of Minnesota*, Minneapolis, Minn.

JOINT MEETING

Friday—June 30, 1933—8:00 p.m.

RED LACQUER ROOM

Some fundamental problems of mutual interest to scientific economists and engineers will be discussed. The meeting has been arranged under the sponsorship of the Econometric Society, American Society of Mechanical Engineers, American Society of Civil Engineers, American Institute of Electrical Engineers, and American Society for Testing Materials.

Some Fundamental Problems of the Engineer.

Dr. F. B. Jewett, *Vice-President of the American Telephone and Telegraph Company*, New York, N.Y.

The Internationalization of Scientific Knowledge as a Factor in World Economic Recovery.

Dr. A. P. Fleming, *Director of Research and Education, Metropolitan-Vickers Electrical Company*, Manchester, England.

L. F. Warrick, *Esq., State Sanitary Engineer*, Madison, Wis.

3:35 **Discussion opened by**

Milton Adams, *Esq., State Board of Health*, Lansing, Mich.

Thorndike Saville, *M. Am. Soc. C.E., Professor of Hydraulic and Sanitary Engineering, New York University* New York, N.Y.

3:55 **Pollution of the Southern End of Lake Michigan**

Arthur E. Gorman, *Esq., Chief Engineer, Water Department*, Chicago, Ill.; and

John R. Baylis, *Assoc. M. Am. Soc. C.E., Physical Chemist, Bureau of Engineering*, Chicago, Ill.

4:25 **Discussion opened by**

Langdon Pearse, *M. Am. Soc. C.E., Sanitary Engineer, The Sanitary District of Chicago*, Chicago, Ill.

Harry F. Ferguson, *Assoc. M. Am. Soc. C.E., Chief Sanitary Engineer, State Department of Health*, Springfield, Ill.

City Planning Division

CLUB DINING ROOM

2:15 **State and Regional Planning**

Jacob L. Crane, Jr., *M. Am. Soc. C.E., Consulting Engineer*, Chicago, Ill.

Yacht Harbor at Jackson Park, Chicago
Boating Enthusiasts Enjoy Every Advantage

Replica of Fort Dearborn
Commemorating the Indian Massacre of 1812

Sanitary Engineering Division

RED LACQUER ROOM

2:15 **The Problem of Sewage Treatment at Duluth**

John Wilson, *M. Am. Soc. C.E., City Engineer*, Duluth, Minn.

2:45 **Discussion opened by**

J. A. Childs, *M. Am. Soc. C.E., Chief Engineer and Secretary, Metropolitan Drainage Commission*, St. Paul, Minn.

L. R. Howson, *M. Am. Soc. C.E., Consulting Engineer*, Chicago, Ill.

3:05 **Industrial Wastes, Their Relative Importance in Stream Pollution**

2:45 **Discussion opened by**

Leslie G. Holleran, *M. Am. Soc. C.E., Deputy Chief Engineer, Westchester County Park Commission*, White Plains, N.Y.

Tracy B. Augur, *Esq., Landscape Architect*, Detroit, Mich.

3:15 **New Opportunities for the Engineer in City Planning**

D. H. Sawyer, *M. Am. Soc. C.E., Director, Federal Employment Stabilization Board*, Washington, D.C.

3:45 **Discussion opened by**

Russell Van Nest Black, *M. Am. Soc. C.E., City Planner*, New Hope, Pa.

4:00 **Discussion**

Hotel Rates—Reduced Railroad Fares—Announcements

Daylight Saving Time

The City of Chicago is on Central Daylight Saving Time, and all meetings and functions on the program are scheduled for Central Daylight Saving Time.

Hotel Reservations

The Palmer House is the Convention Headquarters of the Society and is expected to be able to furnish accommodations for all visitors.

Reservations should be made directly with the hotel. Make reservations at least a week in advance of the Convention, paying for the rooms in advance for at least a part of the period of the visit.

Hotel Rates

	With Private Bath		Without Private Bath	
	Single Room	Double Room	Single Room	Double Room
Palmer House	$3.50 up	$6.00 up	......	......
La Salle Hotel	2.50 up	4.00 up	......	......
Hotel Sherman	3.00 up	4.50 up	......	......
Auditorium Hotel	3.50 up	6.00 up	$2.50 up	$4.00 up
Bismarck Hotel	3.50 up	5.00 up	2.50 up	4.00 up
Chicago Beach Hotel	3.50 up	5.00 up	......	......
Edgewater Beach Hotel	5.00 up	7.00 up	......	......
Hotel Morrison	2.50 up	4.50 up	......	......
Hotel Shoreland	4.00 up	6.00 up	......	......
Congress Hotel and Annex	3.50 up	6.00 up	3.00 up	4.00 up
Hotel Knickerbocker	3.00 up	5.00 up	......	......
Drake Hotel	4.00 up	6.00 up	......	......

Organization Headquarters

For the information of those who may wish to attend the meetings of other societies, their headquarters are given as follows:

American Society of Mechanical Engineers	Palmer House
American Institute of Mining and Metallurgical Engineers	Hotel Stevens
American Institute of Electrical Engineers	Edgewater Beach Hotel
American Association for the Advancement of Science—Section M	Palmer House
American Society for Testing Materials	Hotel Stevens
Society for the Promotion of Engineering Education	Hotel Stevens

Tickets to the Century of Progress Exposition

Admission tickets to the fair will be on sale to members at the Registration Desk at the special price of 50 cents per ticket (including admission to Llama Temple or Fort Dearborn) in any quantity desired.

Trips to Points of Engineering Interest

Information regarding arrangements for visits to special points of engineering or other interest in Chicago and vicinity may be obtained at the Registration Desk.

Invitation to Student Members

All members of Student Chapters are invited to attend and participate in all the events of the Convention.

Entertainment for the Ladies

Attention is directed to the program of entertainment for the ladies. In addition, the ladies are expected to participate in all other features of the Convention that may interest them.

Courtesy of Chicago Engineers' Club Extended to Members

Through the courtesy of the Board of Managers of the Chicago Engineers' Club, the privileges of the club have been extended to visiting members of the American Society of Civil Engineers during their attendance at the Convention.

These privileges include not only the services of the Engineers' Club but also the room service operating through the cooperative courtesy of the Union League Club.

Members of the Society will be presented with guest cards upon application at the offices of the club, 314 South Federal Street, Chicago. In order to avoid unnecessary bookkeeping, house accounts will be handled on a cash basis.

Engineering Societies Committee

The program of events for Wednesday, June 28, 1933, which has been designated Engineers' Day of the Century of Progress Exposition, has been arranged by the Engineering Societies Committee, of which H. B. Gear, Vice-President, Western Society of Engineers, is chairman, and Edgar S. Nethercut, Secretary of the Western Society of Engineers, is secretary.

Golf

On application at the Registration Desk, arrangements will be made for visiting members to play golf at nearby courses. Golf privileges will be subject to the usual greens fees.

Program of Section M (Engineering) of the American Association for the Advancement of Science

Section M is the connecting link between the meeting of the association and that of the engineering societies affiliated or associated with the association. Engineers who are in Chicago during the week of June 19–24, when the association holds its meeting, will find many things to interest them in the pure science programs.

Section M of the association will take part in the following programs during the week of June 26–30:

On Tuesday afternoon, June 27, there will be a joint meeting with the American Society for Testing Materials, at which the Edgar Marburg Lecture of that society will be given by Dr. Herbert John Gough, of England, on "Crystalline Structure in Relation to Failure of Metals, Especially by Fatigue."

On Tuesday evening there will be a general session of the association and all the engineering societies, which Dr. A. P. M. Fleming of England will address on the "Development of Industry and Engineering During the Century."

On Wednesday, June 28, Section M will participate in the events of Engineers' Day, including the banquet.

Reduced Railroad Rates

Reduced fares to the Exposition will be in effect from all parts of the country. At the time of going to press, the following round-trip rates had been made effective:

From the Southeastern and Midwestern Territory:

Fare and one-half, selling daily, limit November 15, 1933.

Fare and one-third, selling daily, limit 30 days.

Fare and one-tenth, good in coaches only, selling daily, limit 16 days.

From the Pacific Coast and Rocky Mountain Territory. Regular summer rates, which range from a fare and one-tenth from Pacific Coast points to a fare and one-third in the Rocky Mountain States. In addition, special excursion tickets with a limit of 16 days will be available from points on the Pacific Coast and intermediate territory at the rate of one fare plus 50 cents.

From Northeastern Territory, which includes all states east of Chicago and north and east of the Ohio and Potomac rivers:

Fare and one-half, selling Tuesdays and Saturdays, limit 30 days.

Fare and one-third, selling Tuesdays and Saturdays, 16 days.

Fare plus 25 cents, selling on Saturdays only, limit 10 days.

Fare and one-tenth, coaches only, selling daily, limit 15 days.

Certificate Plan. In the Northeastern Territory, application has been made for reduced fares on the validation certificate basis, in order to avoid the disadvantage of the selling dates of the special-fare tickets above mentioned.

Tickets at the regular one-way tariff fare for the going journey may be obtained from June 15 to 29, inclusive. If you use this plan be certain to request a Certificate Plan Certificate from ticket agent. **Do not make the mistake of asking for a "receipt."**

The certificate, after having been validated at Chicago, enables the holder to purchase the return trip ticket at one-third the one-way fare, provided such certificates, or a combination of such certificates and round-trip tickets, aggregate not less than 100. Certificates or tickets issued for children of half-fare age are to be counted the same as adult certificates or tickets.

Therefore, if you use the Certificate Plan do not fail to obtain a certificate at the time of purchase of your one-way ticket.

Consult your ticket agent early about reduced rail and Pullman rates before purchasing your ticket.

Special Trains from Eastern Points

Two special trains from the East, to be called the "Engineers' Special" have been set up on the Baltimore and Ohio Railroad, to accommodate members of the Society as well as the members of the American Society of Mechanical Engineers, the American Institute of Electrical Engineers, the American Institute of Mining and Metallurgical Engineers, and the American Society of Testing Materials. These trains will be completely air-conditioned to afford the comfort of a pleasantly cool, clean, and quiet atmosphere in every car, regardless of outside temperature.

The schedule of the Baltimore and Ohio Engineers' Special for Saturday, June 24, is as follows:

Train Schedule	Time	Round Trip Railroad Fares
Lv. New York (42d Street)	9:45 a.m. E.S.T.	$33.00
Lv. Jersey City Terminal	10:30 a.m. E.S.T.	33.00
Lv. Newark (Broad Street Station)	10:20 a.m. E.S.T.	32.65
Lv. Elizabeth	10:46 a.m. E.S.T.	32.50
Lv. Philadelphia (24th and Chestnut Sts.)	12:30 p.m. E.S.T.	29.75
Lv. Baltimore (Mt. Royal Station)	2:30 p.m. E.S.T.	28.00
Lv. Washington, D.C.	3:30 p.m. E.S.T.	28.00
Lv. Pittsburgh	10:00 p.m. E.S.T.	17.15
Ar. Chicago	9:00 a.m. C.S.T.	

Pullman fares for the Saturday train will be sold at one fare and a half for the round trip. For example: New York to Chicago and return, lower berth $13.50; upper berth $10.90; compartment $38.25; drawing room $47.25. Proportionate Pullman fares will be in effect from intermediate points.

These fares apply for tickets limited to a ten days' journey to commence on Saturday, June 24.

The Baltimore and Ohio Engineers' Special for Sunday, June 25, will run on the following schedule:

Train Schedule	Time	Railroad Fares: *Going	Railroad Fares: Return
Lv. New York (42d Street)	10:20 a.m. E.S.T.	$32.70	$10.90
Lv. Jersey City Terminal	11:15 a.m. E.S.T.	32.70	10.90
Lv. Newark (Broad Street Station)	10:50 a.m. E.S.T.	32.39	10.80
Lv. Elizabeth	11:31 a.m. E.S.T.	32.24	10.75
Lv. Philadelphia (24th and Chestnut Sts.)	1:12 p.m. E.S.T.	29.46	9.85
Lv. Baltimore (Mt. Royal Station)	3:03 p.m. E.S.T.	27.78	9.30
Lv. Washington, D.C.	4:15 p.m. E.S.T.	27.78	9.30
Lv. Pittsburgh	9:30 p.m. E.S.T.	16.88	5.65
Ar. Chicago	8:45 a.m. C.S.T.		

* Members traveling on the Sunday Special Train will purchase railroad tickets on the Convention Certificate Plan, which is a full one-way fare going and one-third the one-way fare returning. Secure certificate from ticket agent at time of purchase. For example, the round-trip Convention rate from New York to Chicago is $43.60, tickets limited to 30 days. Pullman fares on the Convention Certificate Plan are at regular tariff rates; for example lower berth, New York to Chicago, $9.00 each way.

Reservations and additional details concerning fares and points not listed here, or other travel information, may be obtained from any Baltimore and Ohio Railroad ticket office.

Order Tickets in Advance

A ticket order form is printed on page 12. Fill this out and forward with check made payable to the Illinois Section, Am. Soc. C.E., Room 1644, 53 West Jackson Street, Chicago, Ill.

Members who order tickets in advance will find tickets and badge awaiting them on arrival at the Registration Desk and will assist the Local Committee by giving advance information to guide it in concluding the arrangements called for in the program.

Local Committee on Arrangements

Paul Hansen, *Chairman*

W. G. Arn
Frank D. Chase
J. D'Esposito
A. E. Gorman
G. C. D. Lenth
George B. Massey
D. B. Rush
F. G. Gordon, *ex-officio Secretary*

Subcommittees

Program Committee: Louis R. Howson, *Chairman;* L. F. Harza, F. E. Morrow, W. S. Lacher, C. L. Post, R. W. Putnam, G. A. Quinlan, J. W. Woermann.

Entertainment Committee: Hugh W. Skidmore, *Chairman;* Loran D. Gayton, C. R. Knowles, H. P. Ramey, R. I. Randolph.

Transportation and Inspection Committee: J. de N. Macomb, *Chairman;* O. F. Dalstrom, H. B. Fleming, H. E. Schlenz, O. E. Strehlow, F. G. Vent.

Publicity Committee: H. P. Ramey, *Chairman;* J. Gardner Bennett, Max Berns, L. D. Gayton, C. R. Knowles, B. B. Shaw, F. G. Gordon, *ex-officio Secretary.*

Golf Committee: Edward Haupt, *Chairman;* C. B. Burdick, John F. Cushing, Warren R. Roberts.

Finance Committee: Murray Blanchard, *Chairman;* Ralph Budd, C. B. Burdick, W. L. Hempelmann, E. J. Mehren, C. A. Money, T. F. Wolfe, W. G. Zimmermann, C. W. Haupt, *ex-officio Treasurer.*

Ladies Entertainment Committee

Mrs. Langdon Pearse, *Chairman*
Mrs. W. W. DeBerard, *Vice-Chairman*
Mrs. Paul Hansen, *Vice-Chairman*

Mrs. John W. Alvord
Mrs. Frank Bachmann
Mrs. Murray Blanchard
Mrs. Frank D. Chase
Mrs. T. L. Condron
Mrs. J. F. Cushing
Mrs. George T. Donoghue
Mrs. Harvey B. Fleming
Mrs. L. D. Gayton
Mrs. Charles W. Gennet, Jr.
Mrs. A. E. Gorman
Mrs. S. A. Greeley
Mrs. Paul E. Green
Mrs. E. O. Griffenhagen
Mrs. A. J. Hammond
Mrs. E. T. Howson
Mrs. Edward J. Kelly
Mrs. W. M. Kinney
Mrs. C. R. Knowles
Mrs. Edward H. Lee
Mrs. L. R. Lohr
Mrs. C. F. Loweth
Mrs. J. de N. Macomb
Mrs. George B. Massey
Mrs. F. E. Morrow
Mrs. R. W. Putnam
Mrs. Robert Isham Randolph
Mrs. A. F. Reichmann

The program as a whole has been prepared under the direction of the Region Meeting Committee, F. G. Jonah, Vice-President, Am. Soc. C.E., *Chairman;* and M. L. Enger, Robert Hoffmann, E. P. Lupfer, and H. E. Riggs, Directors Am. Soc. C.E.

Please call on the Local Committee on Arrangements or on the Secretary's Office for any service desired.

Prompt return of the order form on page 12 will assist greatly.

SOCIETY AFFAIRS

Official and Semi-Official

A Message from the City Planning Division

To the Members of the City Planning Division: The City Planning Division was authorized July 9, 1923. It has concerned itself with the engineering phase of city planning and has brought out through papers, discussions, and progress reports information as to the best practice of the day. The rapid growth of cities, the multiplicity of engineering services demanded, the complex nature of these services, the difficulties of coordinating and directing a city's growth in an orderly way—all emphasized the importance of city planning.

We are now confronted with newer problems. The increasing use of highways has a tendency to spread population. Cities built during a great railroad era will grow more slowly than they did at first, as the sources of population have fallen off. Mutations of residential and mercantile districts will be more gradual. The city which will attract population will be the one that is consistently planned, is honestly built, and gives the most in service—that has the most spacious, convenient, and purposefully designed street thoroughfares; the most attractive parkways, parks, and public squares; the finest recreation system; the most satisfying community life; where taxes are made less burdensome by long-term financial budgets; and where obsolescence and disintegration are treated more scientifically than heretofore.

Planning for Public Works Now

The advancement of the world may be measured in terms of engineering construction. The present distressing economic situation cannot change this fundamental principle of progress. Sound planning must continue during times of depression. If we have built too many plants to make things to sell, we can now balance these by a well ordered program of structures for service.

Surplus money so invested fixes wealth in a permanent form for years of use, while the result of surplus money used wholly for profit is bankruptcy. It is the privilege of the members of the Division to advance the idea of well planned public expenditures and give sober direction to stabilized developments to hasten economic recovery. It is also their privilege to lay a more adequate groundwork for the field of planning, which should need no justification. The moving of thousands of yards of earth, the pouring of thousands of yards of concrete, pouring "one story a week"—even the building of pyramids will be more impressive if the quality of living has been improved.

Sound, self-liquidating projects must now be conceived and designed—"liquidating" through the service they render. Among these may be mentioned public buildings, bridges, sewers and sewage disposal works, tunnels, water supply works, power developments, ports and harbors, slum eradication, adequate housing, rehabilitation of blighted districts, transportation terminals (for rail routes, buses, airplanes, and seaplanes), canals, irrigation structures, thoroughfares or parkways connecting market centers and residence centers, garbage disposal works, incinerators, public markets, express thoroughfares, viaducts, public utilities (such as electric light, gas, telephone, and central heating), hospitals, libraries, schools, museums, reforestation, and home-farms—all coordinated to the needs of the community, the region, or the state.

We are not unaware that in the immediate present tremendous forces are at work opposing government expenditures, and that ill-advised economies are recommended. Propaganda should not affect the engineer's mind. There are 120 million people clothed, fed, and housed in these United States. Shall we urge unemployment, with its corollary of dividends for the idle, or shall we urge employment and its corollary of prosperity?

The disintegration of parts of cities is costing more than all the taxes ever paid on these properties. Tyre and Sidon, those Biblical cities of commerce, perished because their harbors silted up and the people did not know how to dredge. Nomadic tribes became nomads because they could not solve their sanitation problems. Today cities disintegrate or parts of them become blighted because we do not know how to handle obsolescence.

Activities of the Division

It will interest the members of the Division to know that a permanent committee has been set up on the national capital. The purpose of this committee is to work with like committees of the American Institute of Architects and other organizations in developing the national capital not only in an esthetic way, but to recognize its utilitarian needs and make them outstanding as engineering services.

Research committees have also been set up as follows: on Street Thoroughfares, to suggest methods of identifying such thoroughfares according to their use and capacity, and of outlining their design; on the Location of Underground Utilities or Subterranean Street Planning; on Street Naming and House Numbering Plans, with a scientific basis; on Subdivision Plats—Basic Principles and Methods of Control; and on Equitable Zoning of Assessments for City Planning Projects, to devise some set of standards from the innumerable methods used.

The personnel of these committees will be found in the current *Year Book*. Before the end of the year, it is hoped to set up a Committee on Obsolescence, Its Causes and Cures.

We shall appreciate useful ideas and constructive suggestions from all members.

George H. Herrold, *Chairman, City Planning Division*
Clarence O. Sherrill
Russell Van Nest Black
Charles F. Loweth
U. S. Grant, 3d
Harold M. Lewis, *Secretary*

April 17, 1933

Secretary's Abstract of Executive Committee Meeting on May 12, 1933

On May 12, 1933, the Executive Committee met at Society Headquarters. Present were President Alonzo J. Hammond, in the chair; George T. Seabury, Secretary; Otis E. Hovey, Treasurer; and Messrs. Crocker, Mead, Stuart, and Tuttle.

Members in Arrears of Dues

Following the policy expressed in the Annual Report of the Board of Direction, to the effect that contributions in time, effort, and capabilities of the members of the Society are of as great value to the Society as money, the Executive Committee voted to recommend to the Board a procedure with respect to arrears of dues for those members who had loyally supported the Society in the past, and who, because of long continued unemployment are unable to pay their dues.

Public Works

Through contact with the chairman of the Society's Committee on Public Works, the details of the proposed Federal legislation looking toward the construction of projects carried on by public authority or with public aid to serve the interests of the general public were reported to the committee. The legislation to be submitted to Congress by the President was announced as in practically final form, ready for submission to Congress in a very few days. (*Note:* The National Industrial Recovery Act was sent to Congress on May 17, 1933.)

Publication of Surveying and Mapping Control Data

Resolutions adopted by the Executive Committee of the Surveying and Mapping Division of the Society outlining the value of the prompt publication of control data in the form of latitudes, longi-

tudes, azimuths, distances, and elevations to engineers in their private and public practice and to the public were supported by the Executive Committee, which expressed its opinion to the effect that it is not true economy to withhold funds needed for the purpose of essential control survey data. The complete resolution appears elsewhere in this department.

Joint Committee on Water Pollution

Report was received from a survey committee authorized by the Board of Direction at its meeting in January with respect to the practicability and advisability of the establishment of a Joint Committee on Water Pollution to be composed of members of the Society and the American Institute of Chemical Engineers. The report recommends the formation of a joint committee, the present work of which would be the preparation of annotated bibliographies dealing with specific domestic and industrial wastes for which practicable means of treatment have been developed; similar annotated bibliographies dealing with industrial wastes for which there are at present no known practicable treatment processes; and, at later dates, annual summaries of advances in the development of treatment processes for each specific waste. The committee was authorized and directed to cooperate with professional organizations and other research agencies engaged in water pollution researches in this country and in Europe.

Continuing Engineer-Architect Joint Committee

As a result of negotiations between officers of the Society and officers of the American Institute of Architects, a joint committee composed of representatives from each organization is proposed for the purpose of considering and providing procedures for the amelioration of such differences as from time to time appear to exist between the professions of engineering and architecture. Such a committee would include within its functions the development of a national attitude, a mutual respect between the two professions, and mutual cooperation on matters of interest common to both.

Federal Reorganization; Engineer-Architect Joint Committee

As a result of negotiations carried on between officers of the Society and those of the American Institute of Architects, there is proposed the formation of a Joint Engineer-Architect Committee to give immediate study to the advisability of the reorganization of Federal departments, having to do with construction matters of interest to the two professions, more especially in connection with the proposed Department of Public Works. The Executive Committee authorized the appointment of such a committee and the selection of its personnel by the President of the Society.

Coordination of Joint Activities

The Executive Committee was in receipt from the Coordination Committee of Engineering Societies of a progress statement dated May 1, 1933. The statement deals with the relationship of the United Engineering Trustees, The Engineering Foundation, the American Engineering Council, and the governing boards of the four Founder Societies. Summarizing its statement, the committee does not recommend any drastic change in the composition of these agencies. However, it does propose that certain modifications might wisely be made which would improve their usefulness.

The progress statement recommends a Joint Advisory Board, composed of the presidents, secretaries, and two members of the governing boards of each of the Founder Societies. The duties of this board are indicated as to consider proposed joint activities which may be referred to it, or which may be initiated by it; to review the progress of all joint activities already extant; and to make joint recommendations to such societies as may be interested as to whether proposed activities should or should not be undertaken, and through what agency an approved activity should function. With respect to the United Engineering Trustees, The Engineering Foundation, and the American Engineering Council, the comments were generally to the effect that these agencies should be more responsive to the governing boards of the Founder Societies. The progress statement was referred to the Board of Direction for its information.

Modification of the Budget

Marked decrease of income, normally arising from dues, necessitated an equal reduction in proposed expenditures for the fiscal year. Among other administrative reductions in expenditures, it was decided that allotments to the Local Sections should be for this fiscal year at the rate of 60 per cent of the base rate established by the Board of Direction at its meeting held in January last. The Executive Committee will recommend to the Board of Direction at its meeting to be held in June, that there be no Fall Meeting of the Society this year.

Acting as the Finance Committee of the Society, other methods of curtailment of expenditures were determined by the Executive Committee with respect to administrative details, work of certain of the committees, administration of the Technical Divisions, and possible modifications in the publication program.

Arch Dam Committee Renders Final Report

Recommendations for Designing, Constructing, and Testing Arch Dams

Recognizing the pressing need for more complete knowledge based on scientific observations, in order to secure greater safety and economy in the design and construction of arch dams, engineers in 1922 appealed to The Engineering Foundation for aid. A Committee on Arch Dam Investigation was organized and met for the first time early in 1923. One of the activities of the committee resulted in the construction and physical testing of a thin arch dam 60 ft high on Stevenson Creek in California.

In May 1928 a progress report, with preliminary conclusions, was printed as Part 3 of PROCEEDINGS. *In 1931 a report on the making and testing of models of dams and on extensive tests of concrete of the kind used in dams was issued in mimeographed form for filing in libraries and a few other selected places. No money was available for its publication. Recently the U.S. Bureau of Reclamation, which did most of the work, in cooperation with the Arch Dam Committee, has undertaken to publish this report.*

Since that time, the many phases of the research program have been concluded and the final report of the committee has been put in manuscript form. It will be printed shortly by The Engineering Foundation. For the immediate information of members, the committee's conclusions and recommendations are given here in full.

THE COMMITTEE believes that its work, in connection with that of its numerous cooperators, has established many facts despite negative or inconclusive results of some tests.

The committee feels warranted, therefore, in submitting certain general recommendations, which it hopes will be helpful in designing, constructing, and testing future arch dams, and in testing existing dams to establish their safety or to determine the feasibility of increasing the height or making other alterations.

Recommendations

1. In view of the facts assembled by the investigation and because an arch dam is, at best, many times statically indeterminate, it is not to be expected that a theoretically exact method of analysis can be developed; but it is believed that any of the current methods of arch dam design based on the elastic theory will probably give safe dams so far as the mathematics of design is concerned, though of various efficiencies. The more complex theories are concerned with refinements not necessarily essential to safe mathematical design, except perhaps in dams of extreme height or other unusual conditions, as must be determined by the judgment of the designer. The methods of design listed here are probably ascendingly accurate, and certainly complex in theory, in the order given:

a) An assumed series of independent elementary arches that support the entire water load.

b) An assumed series of horizontal arch elements and one central vertical cantilever element, the water load being divided between the arches and the cantilever.

c) An assumed series of both horizontal arch and vertical cantilever elements, with a corresponding division of the water load between the two systems.

d) The same as (*c*) except that the concrete indicated by the analysis as being under excessive tension, or cracked, is neglected except for weight.

e) An assumed action of the dam as a monolithic shell, involving structural theory corresponding to that of the dome.

The "cylinder formula" is excluded because it is entirely inadequate to represent the stress conditions that actually occur, although useful for preliminary design. Employing the terminology of this report, that formula may be written $\sigma = \frac{wR}{t}$ in which σ is the arch stress, w the water load, R the upstream radius, and t the thickness of the arch.

Note: So far as records go, no arch dam has ever failed by reason of structural weakness of the arch. The very few instances reported were not failures of the arch proper but rather of the foundations or natural arch abutments. This practically unmarred record is the more remarkable in view of the fact that most early arch dams were designed by crude methods using the "cylinder formula." A design by any of the methods based upon the elastic theory should result in a dam that is safer and/or more economical.

2. When the analysis of an arch dam indicates tension stresses or cracks, the section of concrete cracked or in tension may be neglected except for its weight, provided the resulting compression stresses upon the remainder of the section are within the permissible limits. A design substituting secondary interior arches for the primary arch elements is not favored. By "secondary interior arches" are meant arches of shorter radii and smaller thickness contained within the original arches, and which are sometimes assumed to develop inside the original arches after these have developed cracks in zones of excessive tension stresses.

3. Construction methods should be coordinated with design assumptions, so that the dam will act in accordance with the latter, as nearly as is practicable.

4. For the construction of arch dams the use of low-heat cement is recommended, and/or the adoption of all practical measures to prevent the generation of high chemical heat in the concrete. Artificial cooling of the concrete, the providing of joints or slots and filling these at the proper time, as indicated by the conditions, are recommended for consideration.

5. Vertical radial contraction joints spaced from 40 to 50 ft apart should be provided. The possible benefits from further articulation of the structure by horizontal sliding joints or hinges should be investigated.

6. Models. The structural behavior of proposed large arch dams should be investigated with models. In the comparison between prototype and model, due consideration must be given to complications in the dam, resulting from temperature and shrinkage phenomena which will not occur to any appreciable degree in the model.

7. In tests on concrete dams, particular emphasis should be put on the deflections. The best method now known to the committee is precise triangulation. The arrangement should be such as to measure the movement of points on the dam located in at least three, and preferably five or more, vertical lines, and also the movement, if any, of the base of the dam on, or with, its foundation. To ensure reliable results, the use of a theodolite as required for triangulations of the first order is recommended, at least for high dams. All observations should preferably be made from three, instead of the customary two, observation piers.

Note: In connection with the experimental dam it was my feeling that the use of the vertical clinometer gave the deflections very accurately, and the results were certainly available at once and without an extended computation such as would be required in triangulations. In approving this recommendation I have had in mind, however, that the experimental dam offered facilities that would not be available on any ordinary structure, and while the direct measurement was very satisfactory for the experimental dam, it might be entirely impracticable for a high arch. H. W. DENNIS. [See page 75 of 1928 report.]

8. The temperature of the concrete of arch dams should be measured at as many points as practicable, to furnish information necessary for successful grouting of contraction joints, and for other purposes.

9. The measurement of strains is generally of very doubtful value, and when employed should be made only in long continuous lines extending, if practicable, from abutment to abutment and from top to bottom of the dam.

10. Working unit stresses in concrete for purposes of design of dams cannot advisedly be given in the form of a general recommendation. Among reasons which may be given are the following:

a) With the allowed unit stress is involved in part the margin of safety. Inasmuch as the margin of safety should, in a considerable degree, be proportional to potentialities of disaster in the event of failure, the allowed unit stresses should vary with the situation of the dam all the way from what would be allowable in a dam with small potentialities to possibly less than one-half as much in a dam, the failure of which would be a disaster with great loss of life and property. Fortunately the maximum unit stresses usually may be decreased at a relatively small increase in cost.

b) In order safely to specify permissible unit stresses, definite knowledge is needed of the materials and methods to be used in mixing and placing the concrete and the control of other features of construction for each dam. Construction methods may greatly influence actual stresses.

c) The designing engineer must know for each dam the provision to be made for determining and controlling the quality and strength of the concrete actually placed in the dam.

These recommendations are directed to competent engineers; they are not intended for untrained persons.

COMMITTEE ON ARCH DAM INVESTIGATION

Charles D. Marx, *Chairman*
Fred A. Noetzli, *Secretary*
Paul Bailey
George S. Binckley
C. Derleth, Jr.
Alternate, R. E. Davis
H. W. Dennis
Alfred D. Flinn
D. C. Henny
M. M. O'Shaughnessy
H. Hobart Porter
Alternate, Wynn Meredith
J. L. Savage
Alternate, Ivan E. Houk
F. E. Weymouth
Alternate, Julian Hinds
Silas H. Woodard

Copies of the final report will be supplied to all contributors to the support of the investigation, without charge. To make this costly and useful information readily available to other persons interested in design, construction, tests, inspection, supervision, maintenance, or alteration of arch dams, copies of the report will be offered for sale at $3.00 each. To members of the Society a special price of $2.00 will be made. Orders, with remittance, may be sent to The Engineering Foundation, or to the Society, both at 33 West 39th Street, New York, N.Y.

New York State Perfects Its License Laws for Engineers

By D. B. STEINMAN, M. AM. SOC. C.E.
PRESIDENT, NEW YORK STATE SOCIETY OF PROFESSIONAL ENGINEERS

AFTER YEARS of effort, the registration of engineers in New York is now approaching an ideal. The existing registration law, as amended by recent bills passed by the State Legislature, conforms to the Society's "Model Registration Law for Professional Engineers and Land Surveyors," practically in its entirety. Four bills signed by the Governor of New York late in April vitally affect the interests of engineers and architects in the state. They give a broader recognition to the status of these two professions and more accurately define their relation to public welfare and safety.

Through an amendment to the Multiple Dwelling Law, Section 300, the right of licensed professional engineers to file plans for multiple dwellings and any other buildings or structures, and any alterations to them, has been completely restored and legally established. The bill corrects a wrongful discrimination, which was inadvertently written into the law in 1929 and which has deprived a number of highly competent engineers of their established means of livelihood.

Last year the architectural profession in New York generously pledged itself to cooperate with the engineering profession in securing the correction of this discrimination. Accordingly, the bill just enacted was sponsored and endorsed jointly by both professions. In preparation for this legislation, during the past few years, the licensing laws for the two professions were raised to the same high level of qualification requirements. In addition to the requirements of character, professional education, and years of professional experience, both engineers and architects are required to pass a comprehensive four-day written examination. This has been required since 1931 for non-graduates of registered engineering colleges and goes into effect for graduates in 1937. Candidates for either license must show evidence of ability safely to plan, design, and supervise the construction of buildings and other structures, and since 1932 have been required to pass a written examination in structural planning and design.

Both licensing laws establish complete reciprocity of professional

practice, so that licensed architects are legally permitted to practice engineering and licensed engineers to practice architecture. Both licensing laws further provide that plans for buildings as well as other structures must bear the seal of either a licensed professional engineer or a licensed architect. The enactment of the present bill finally removes the one remaining discrimination against the engineering profession, and establishes both professions on a complete parity in respect to all phases of structural work. The success of this legislation serves to cement the relations of harmonious accord and mutual cooperation that have been established between the two professions, and at the same time protects the best interest of the public.

Through amendment to one section of the Engineers License Law, the phrasing of that part of the bill which restricts the unlicensed use of professional designations has been improved and clarified so as to facilitate enforcement. The public has been deceived and misled by unlicensed men who display such designations as "Consulting Engineer," "Mechanical Engineer," or "Surveyor." The former phrasing of the statute prevented effective correction of such evasions of the law. The new phrasing fully restricts the use of the professional designations to licensed men so as clearly to protect the designations "Engineer" and "Surveyor," and not merely those of "Professional Engineer" and "Land Surveyor." With this amendment it will be possible to prosecute those who continue to deceive or mislead the public by calling themselves "Engineers" or "Surveyors" when they are not licensed as "Professional Engineers" or "Land Surveyors." An amendment to another section of the Engineers License Law eliminates an inconsistent exemption which permitted unlicensed men to practice land surveying in rural districts. This exemption had no justification and its elimination is clearly in the public interest.

A third bill further amends the Engineers License Law so as to stop present evasions of the law by unlicensed men who report preliminary estimates as under $10,000 for larger buildings and structures which they undertake to design and build without a professional license. The new amendment simply adds a cubic content specification to the present cost specification limiting the size of buildings and structures that may be designed by men who are neither licensed engineers nor licensed architects. The cost specification alone has proved insufficient to prevent abuses and evasions of the law.

Section 1452 is amended by raising the minimum definition of "long established and recognized standing in the engineering profession," for exemption from the examination requirements for licensing, from 12 to 15 years. In addition, the bill eliminates the "grandfather clause," exempting from examination requirements those who were practicing prior to 1916. The bill also includes a complete new section covering disciplinary proceedings so as to improve the effectiveness of this section of the engineers licensing law. The provisions have been amplified to permit the Engineers Board to recommend revocation, suspension, or annulment of license, or reprimanding, censoring, or otherwise disciplining any licensed engineer found guilty of violating the principles of professional conduct.

The fourth bill just signed by the Governor, amends the Architects License Law parallel to the amended Engineers License Law. The engineering profession cooperated with the architects in securing the enactment of this bill.

There are 10,000 licensed professional engineers in New York State and 3,000 licensed architects. The Legislature recognized the sincerity of both professions in recommending and sponsoring these measures, and the approval by the Governor was also based on respect for the two professions and recognition that this legislation was in the best interest of the public. This cooperative effort has resulted in a law that may be considered as the high point in the registration and licensing of engineers.

Memoir of John A. Roebling

With the recent publication of the memoir of John A. Roebling, a valuable addition has been made to the archives of the Society. This illustrious pioneer in the science of suspension bridges and head of the American family that has made such an important place for itself in the building of long-span bridges, was one of the early members of the Society; in fact, he died in 1869, when the total membership numbered less than two hundred.

It may seem strange that the publication of this memoir has been so long delayed. Of late years, when increasing efforts have been made to fill the gaps in the list of published memoirs, attention has been focused on the historic records of a number of notable members, among them Mr. Roebling. For one reason or another, this particular task was difficult. But with the celebration in May of the 50th anniversary of the completion of Brooklyn Bridge, a monument to John A. Roebling, these efforts were rewarded and the memoir is now available. It represents the combined result of studies by the Headquarters staff, and the cooperation of officials of the John A. Roebling's Sons Company.

Special significance attaches to the publication of the memoir at this time, when the Brooklyn Bridge is receiving so much well deserved attention. Passing years have only magnified the importance of this structure in the field of American transportation and the immense contribution made by its illustrious builders to engineering progress. The memoir forms a fitting companion piece to the article in this issue on the history of the Brooklyn Bridge, by Edward A. Byrne, M. Am. Soc. C.E. Copies of the memoir are available on request to the Secretary's office.

Publication of Control Survey Data

At the meeting of the Executive Committee held on May 12, 1933, the following resolution was adopted favoring the publication of essential control survey data obtained by various Government agencies:

"Whereas, Control data, in the form of latitudes, longitudes, azimuths, distances, and elevations secured by the agencies of the Federal Government, are essential to the proper execution of the various classes of engineering work, including surveying and mapping; and

"Whereas, The necessity for reducing the expenditures of the Federal Government has resulted in the curtailment of funds usually made available for publishing surveying data; and

"Whereas, The cost of printing the data in question is insignificant as compared with what has been spent on the field and office work required to make the observations, computations, and adjustments; and

"Whereas, The data are invaluable to engineers in private and public practice, to educational institutions, and to the public, all of whom have a right to the results secured by the expenditure of their money paid to the Federal Government in the form of taxes; and

"Whereas, The data now in manuscript form only cannot be considered as readily available to the citizens of this country; therefore be it

"*Resolved*, That the Executive Committee of the American Society of Civil Engineers expresses its opinion that it is not true economy to withhold funds needed for the publication of essential control survey data."

Local Section Papers for Civil Engineering

In its report to the Annual Meeting of the Board of Direction, the Special Committee on Local Section Allotments appropriately called attention to the possibilities for giving publicity to important papers originating in, and delivered before, Local Sections. The committee brought forward the fact that since the inception of Civil Engineering 18 such papers from 9 Local Sections of the Society have appeared in this publication.

As regards the submission of papers to Civil Engineering, the practice of the various Sections differs; many never submit their papers, while the Metropolitan and Panama Sections make an invariable habit of submitting every paper presented at their meetings. It goes without saying that by no means can all these papers be accepted. A paper may be of specialized local interest; it may duplicate others already printed or awaiting publication; it may not be of general civil engineering interest; or it may not fit into the immediate publication needs.

If a paper meets with an enthusiastic reception at a Section meeting, it should be assumed that it is worthy of consideration for possible Society use. The Committee on Publications is always glad to receive such papers and to give them its attention.

Metropolitan Engineers Complete Second Winter of Relief Activities

Campaign to Aid Unemployed Engineers Continued by the Profession in the New York Area

By FREDERIC R. HARRIS, M. AM. SOC. C.E.

FORMERLY GENERAL CHAIRMAN, PROFESSIONAL ENGINEERS' COMMITTEE ON UNEMPLOYMENT

AT the conclusion of the second winter's activity of the Professional Engineers' Committee on Unemployment, commonly called the P.E.C.U., Admiral Harris, General Chairman from October 1932 to April 1933, renders this report of results accomplished. Under his leadership the P.E.C.U. aggressively continued its relief work among unemployed engineers in Metropolitan New York. On April 3 he found it necessary to resign as General Chairman in order to accept an appointment to a wider field of similar activity for the City and State of New York. The work of the P.E.C.U. continues under the energetic leadership of W. A. Shoudy, Mem. A.S.M.E. In CIVIL ENGINEERING *for January 1933 appeared the report of the committee's first year of work under the chairmanship of J. P. H. Perry, M. Am. Soc. C.E.*

A BRIEF capitulation, as of April 1, 1933, of the work done by the Professional Engineers' Committee on Unemployment, during the period from October 1, 1932, to the middle of March 1933, follows.

During this period, 2,468 unemployed engineers were registered. Of these active registrants, men were placed in positions divided as follows:

On P.E.C.U. payrolls	80
Receiving other relief work, such as that given by the Emergency Work Bureau and other general public committees in the Metropolitan District of New York	510
In permanent jobs (engineering and otherwise)	227

The 817 placements represent 47 men placed more than once, or a net total of 770 individuals provided with jobs in 1933. In other words, we were able to find work for 33 per cent of all the engineers who registered with the committee. The division among Society members and non-members, both as to registration and placements, is shown in Table I.

TABLE I. RECORD OF REGISTRATIONS AND PLACEMENTS

Society Membership	Registered	Percentage of Total Registered	Placed	Percentage of Total Placed	Percentage of Registered Placed
A.S.M.E.	439	17.8	173	21.2	39.4
A.S.C.E.	287	11.6	125	15.3	43.6
A.I.E.E.	216	8.7	92	11.2	42.6
A.I.M.E.	41	1.7	14	1.7	34.1
Naval Arch.	8	0.3	4	0.5	50.0
Former members	98	4.0	30	3.7	30.6
Non-members	1,379	55.9	379	46.4	27.5
Totals	2,468	100.0	817	100.0	
Men placed more than once			47		
Total men placed			770		

TABLE II. CLASSIFICATION OF REGISTRANTS

Marital Status	Registered	Placed
Married	1,618	647
Single	800	146
Widowed	26	14
Divorced	24	10
Totals	2,468	817

Former Salary Status	Registered	Placed
$6,000 or more	129	50
3,600 to 6,000	565	221
2,400 to 3,600	1.097	406
2,400 or lower	677	140
Totals	2,468	817

Registration by Area	Registered
Boroughs of New York City:	
Manhattan	523
Brooklyn	563
Queens	275
Bronx	271
Richmond	63
Total	1,695

OBTAINING THE FUNDS

The securing of the necessary funds for the work of the P.E.C.U. was under the direction of T. F. Barton, Member A.I.E.E., Chairman of the Finance Committee. Up to April 1, 1933, this committee had secured $40,031.51 which, in addition to the balance of $20,242.63 turned over by the previous organization, made funds available to April 1 for this year's operations of $60,274.14, not including $5,562.50 in unpaid pledges. Besides this contribution of cash, donations of clothing have been obtained of a conservative second-hand value of $2,796.35, making in all $68.632.99, as of April 1, to which should be added $3,028.04 in cash for administration purposes, a grand total of $71,661.03. An analysis of contributed funds is given in Table III.

TABLE III. SOURCES OF CONTRIBUTIONS

Society	Number of Contributors	Percentage of Total	Percentage of Membership in P.E.C.U. Territory	Total Contributions	Percentage of Total Contributions	Average per Person
Civil	347	22.1	13.9	$13,783.13	34.4	$39.72
Electrical	575	36.6	16.4	10,574.34	26.5	18.39
Mechanical	432	27.5	8.5	9,648.30	24.1	22.33
Mining	122	7.8	9.6	3,968.20	9.9	32.44
Non-members	94	6.0	51.6	2,057.54	5.1	21.89
Totals	1,570	100.0	100.0	$40,031.51	100.0	$25.50

In addition to the relief afforded directly from the funds of the P.E.C.U. and other aid obtained from public and quasi-public relief organizations, as previously set forth, unemployed engineers have been placed in permanent jobs, engineering and otherwise, and have received a wage return estimated at $40,888. While this figure is approximate, it is based on a post-card survey and individual check, and is believed to be reasonably accurate.

It thus appears that the total "relief" made available for registered unemployed engineers by the P.E.C.U. for the six-month period covered by this report was as follows:

Cash for relief funds	$63,879.39	
Cash for administrative purposes	3,028.04	
Second-hand clothing of value	3,863.45	
Unpaid pledges as of Sept. 30, 1932, still regarded as collectable and good	1,982.25	
		$72,753.13
Value of wages paid to P.E.C.U. registered engineers by other relief organizations		$193,838.00
Wages earned by P.E.C.U. registered engineers on permanent jobs (engineering and otherwise)		40,888.00
Total "relief made available through P.E.C.U."		$307,479.13

DISBURSEMENTS ACCOUNTED FOR

In the period covered by this report, the P.E.C.U. made disbursements from funds at its command as follows:

Salaries to registered unemployed engineers employed by the P.E.C.U.	$24,855.00
Loans and emergency loans	4,991.00
Clothing (conservative second-hand value)	2,796.35
Total	$32,642.35

On April 1, 1933, the outgoing P.E.C.U. administration, under my general chairmanship, turned over to the new officers, Prof. W. A. Shoudy and his associates, funds as follows:

Cash	$40,031.41
1932–1933 pledges receivable (still regarded as good)	3,580.25
Second-hand clothing valued at	663.25
Additional contingent assets of notes receivable for loans made to unemployed engineers	5,933.75
Total	$50,208.66

The item of administrative expense represents printing, postage, telephone, and traveling expenses. It does not include anything for rental. Office space was provided by the United Engineering Trustees, Inc., and the four Founder Societies, in the Engineering Building; for part of the time by the very generous donation of the American Radiator Company; and also for the Clothing Department, for the entire period, by the McGraw-Hill Company in the McGraw-Hill Building. The administrative expense has been less than one per cent of the total relief afforded.

The payroll of the administrative staff is not included in this administrative expense. In addition to the volunteer workers, the staff, although varying, has run as high as 62 men. As these were all unemployed engineers, and during this period all new appointments were confined to destitute Class A cases, this cost is considered as part of the relief afforded and not as administrative expense.

The extent of the relief to individual unemployed engineers through the P.E.C.U. has varied somewhat depending on the character of the work and where obtained. The average, as nearly as can be determined, is as follows:

For those paid directly through the P.E.C.U.	$17.21 per week
For those who obtained relief through the Gibson and other public relief committees	15.87 per week
For those who secured permanent jobs, engineering or otherwise, through the P.E.C.U.	28.00 per week

Social Service Rendered

The human side of the present unemployment problem was well handled by the Social Service Division, which had an emergency cash fund so that it could advance money up to $3 to individual engineers in immediate need, for carfare and other urgent disbursements. It also distributed food cards furnished by one of the city relief committees and meal tickets furnished by P.E.C.U. funds. Food to the amount of 44,495 lb was distributed to 225 families. The further activities of the Social Service Division were as follows:

Clothing (not including Red Cross issues):		
Number of applicants		446
Issues for men		332
Issues for women		81
Issues for children		140
Total value of clothing issued	$3,845.50	
Total value of clothing received	3,863.45	
Children's shoe fund:		
Pairs issued		77
Value	142.43	
Medical aid and hospitalization:		
Number of applicants (dental 3, medical 2, eyeglasses 2)		68
Number aided, including dependents		71
Lodging relief:		
Number of applicants (rent relief)		18
Number aided, including dependents		29
Home mortgage foreclosure relief:		
Number of applicants		13
Number aided, including dependents		29
Public utility service—electric, gas, and telephone service cut-off postponed:		
Number of applicants		13
Number aided, including dependents		28
Coal issues:		
Number of applicants		9
Number aided, including dependents		25
Cases referred to Women's Committee		197
Legal aid		14
Patent aid		3

This division was materially aided by the Women's Committee, consisting of members of the Engineering Woman's Club, of which Mrs. Josephine M. Barron, president of the club, is chairman, and Mrs. E. L. Dolbear is executive secretary. While the committee functioned only from the first of January, it had handled 197 cases up to April 1. Food was supplied to 41 families, and through the generosity of William Heyman, Assoc. M. Am. Soc. C.E., director of this administration's funds, shoes were furnished to children under 14 years of age.

The Women's Committee is also directly cooperating in supplying clothing, medical aid, fuel, miscellaneous aid, and direct monetary assistance of an emergency nature to 34 families. Besides the cash furnished to the Women's Committee, they were supplied with the services of a trained nurse, whose compensation was paid from the P.E.C.U. funds.

Men Furnished to Societies and Institutions

The P.E.C.U., while providing employment in the way of made work this year, allowed $15 per week to an individual and furnished men for work of an engineering character to assist engineering societies, engineering colleges, or other public or semi-public institutions. Each request for assistance was carefully scrutinized on its merits and only approved if the work was of a useful engineering nature and was not a substitute for, or replacement of, work that the institution would do with its own funds. On this basis the following positions were furnished:

Institution	Members Placed
Stevens Institute of Technology	1
American Society of Mechanical Engineers	7
Engineering Societies Library	4
American Society of Civil Engineers	4
New York University	8
Columbia University	3
American Institute of Mining and Metallurgical Engineers	4
The Polytechnic Institute of Brooklyn	2
National Committee on Trade Recovery	4
Total	37

Registrants have stated to investigators that they wanted neither money, food, nor clothing, but they did want work of any description. With that idea in mind, the job-finding activities of the Relief Committee were expanded. At present there is a canvasser in all the four boroughs and in northern New Jersey, calling on employers of labor in an endeavor to secure openings for our registrants. They have been helped by members of the Founder Societies, who have suggested possible employers and given representatives letters to possible employers. Activities have not been confined to engineering positions, but jobs of every description have been listed and filled. As a result of this campaign, a much larger proportion of the registrants have been placed in non-relief jobs than were placed last year at the same period.

In addition to the regular free course at Columbia University for unemployed engineers. The Engineering Foundation arranged for a series of courses in the Engineering Building, which the P.E.C.U. agreed to finance to the extent of $750. It made an allowance of $5 per week per instructor for personal expenses in connection with the course.

Loans Without Interest

The P.E.C.U. decided that for this year it would prefer expending its own funds to make loans and advances to deserving destitute cases, if possible, rather than expending a similar amount of money for made-work projects, having in mind that loans should appeal to self-respecting unemployed engineers, and in this emergency, when all their other resources and credit were used up, could be paid back some time in the future, when they were employed. The loans were made on the basis of a demand note without interest, on the reverse side of which the following was printed:

Borrower Please Read

The money advanced and loaned to you in connection with this note is taken from funds donated or subscribed by Engineers, principally Members of the Four National Societies, which funds were donated or subscribed to assist brother-engineers in temporary financial distress as a result of the present business crisis. These funds are lent to you without interest and with the understanding that when you are again in more fortunate circumstances, or are employed, you will repay the amount so that it may in turn be used to help other engineers who are in need of such help. By this loan we are

extending to you a helping hand, and you are incurring an obligation to, in turn, when you can do so, extend a helping hand to those still in need of it.

From this you can see—if you can ever pay this money back and do not do so—you will be withholding money that rightfully belongs to fellow-engineers in need of help.

These loans ran from $25 to $100 and up to April 1 totaled $4,991. Eight of these, amounting to $390, have been repaid.

In addition to these formal loans, smaller amounts were advanced for immediate emergencies. In the case of non-members, they were limited to $3, and in the case of members to $5, this amount being advanced to a member who was eligible for a regular loan to render immediate financial assistance until the application for the loan had gone through.

While all the services, such as registration, securing employment, welfare, and other assistance were open without discrimination as to society membership to unemployed engineers who had resided in the Metropolitan area of New York City for two years, the formal loans were available only to members of the five societies who had been members in good standing up to and including November 1928, and in the same way employment in the administration force or on made-work jobs was restricted similarly. The relatively small number and amount of the loans seemed disappointing at first, but is readily understood when it is realized that these were available only to "Class A member (destitute) cases," and that in this classification the committee had found employment for practically every one. In all, only 32 members in Class A were not placed in employment and did not apply for loans.

Of the 668 Class A men registered, 439 have been placed; 385 with city bureau and the P.E.C.U. and 54 with individual employers. Of these, 230 are members and 209 non-members.

This leaves 229 who had not yet been placed, although of these 64 have received loans and are members; 133 are non-members who have not been placed and have not received loans; 32 members have not been placed and have not requested loans, although some of them have received emergency loans up to $5.

With a view to expanding assistance in the way of loans, the Executive Committee decided to make Class B cases, on the basis of the restriction to members and on the individual requirements of the applicant, available for loans.

Acknowledgment should be made of the generous assistance and cooperation given by the secretaries of the four Founder Societies; by the General Committee; by the Executive Committee; by Col. C. M. Estabrook, Member of the Society of American Military Engineers; by Alfred H. Meyer, Assoc. Mem. A.S.M.E., Executive Secretary; and by the staff of the American Society of Mechanical Engineers. Appreciation is also acknowledged to Ole Singstad, M. Am. Soc. C.E., Director of Relief; William Heyman, Assoc. M. Am. Soc. C.E., Director of Administration of Funds; Alfred D. Flinn, M. Am. Soc. C.E., Chairman of the Clearance Committee; A. S. Diven, Assoc. M. Am. Soc. C.E.; T. F. Barton, Fel. A.I.E.E., Chairman of the Finance Committee; Ralph T. Rossi, Assoc. A.I.E.E., Assistant Director of Relief; James M. Webster, Assoc. M. Am. Soc. C.E., Assistant Director of Relief; Mrs. Josephine. M. Barron; Mrs. E. L. Dolbear; H. C. Griswold, M. Am. Soc. C.E.; S. G. Hess, M. Am. Soc. C.E.; C. T. Wilson, M. Am. Soc. C.E.; and all the assistants on the staff of the P.E.C.U. for their loyalty and cooperation.

News of Local Sections

Alabama Section

A meeting of all the engineering societies of Birmingham was held in that city on April 22, under the auspices of the Alabama Section. The speaker of the occasion was John F. Coleman, Past-President of the Society, who gave a detailed account of the operation of the Reconstruction Finance Corporation. Mr. Coleman is a member of the board of engineering advisors to the corporation, and his timely talk elicited much discussion.

Central Illinois Section

On April 21 the Central Illinois Section held its regular bimonthly technical meeting at Urbana. An illustrated address was given by S. C. Hollister, Professor of Structural Engineering at Purdue University, who described the research work on stresses in welded connections that is being carried on at Purdue. The general interest in this subject was indicated by the attendance of 37, the largest of the year.

Chattanooga Section

The first meeting of the Chattanooga Section was held on March 14, with 16 members in attendance. At that time it was decided to hold monthly luncheon meetings, and the membership was very enthusiastic at the suggestion. On April 4 several members of the Section called on the Governor of Tennessee in the hope of enlisting his support in securing a state appropriation for topographic mapping of certain quadrangles in the eastern part of the state.

Cincinnati Section

The guest speaker at the annual meeting of the Cincinnati Section, held at the Gibson Hotel on May 3, was Alonzo J. Hammond, President of the Society, who discussed Society affairs and activities involving the welfare of the engineering profession as a whole. The student award for the past year was then made to Robert Ziegler, a senior in the engineering college of the University of Cincinnati. The Section elected officers for the ensuing year as follows: E. K. Ruth, President; J. S. Raffety, Vice-President; and Clifford N. Miller, Secretary-Treasurer. There were 50 members and guests present at the meeting.

Connecticut Section

There were 20 present at the fourteenth annual meeting of the Connecticut Section, held in New Haven on April 28. Included in the business session was the election of officers for the ensuing year. This resulted as follows: William R. Copeland, President; John C. Tracy, Vice-President; and Joseph P. Wadhams, Secretary-Treasurer. Mr. Copeland briefly outlined a program for the coming year and spoke of the problem of financing various public works projects in the state that would provide employment for engineers and others.

Dayton Section

The April meeting of the Dayton Section, which was held on the 8th, consisted of an inspection trip to the new Cincinnati Union Terminal. A party of 41, including 19 members of the Section, 15 members of the University of Dayton Student Chapter, and 7 guests, made the trip by bus from Dayton. They were shown the various railroad approaches, bridges, and buildings forming a part of the terminal development by E. W. Clark and Roger Bear, both of whom are members of the terminal engineering staff.

Georgia Section

The Atlanta Athletic Club was the scene of the regular monthly meeting of the Georgia Section held on May 1. There were 47 in attendance at the luncheon and 61 at the lecture following. This lecture was given by E. T. Killam, of New York, N.Y., whose subject was "The Trend Toward Chemical Processes of Sewage Treatment."

Kansas State Section

A meeting of the Kansas State Section was held in the Kansan Hotel in Topeka on April 21. The guests of honor were E. B. Black, Director of the Society; E. J. Peltier, of Kansas State College; and Charles Kinney, of Kansas University. The last two are recipients of the Local Section prizes awarded annually to honor students in civil engineering. Mr. Black gave an interesting talk on Society affairs, and George S. Knapp, Chief Engineer of the Division of Water Resources of Kansas, discussed the Government's attitude toward unemployment.

Los Angeles Section

Following an annual custom, the May meeting of the Los Angeles Section was held at the California Institute of Technology, at Pasadena, on May 10. An attendance of 190 members and guests was attracted by the varied program, which was sponsored and arranged by the California Institute of Technology Student

Chapter. The aims and status of graduate work were outlined by Franklin Thomas, head of the Department of Civil Engineering at the Institute. He was followed by a number of graduate students who described current investigations and the results so far obtained. The subjects discussed included the following: a photoelastic method of stress determination; model tests of erosion and silting at the Alamitos Bay outlet of San Gabriel River in connection with flood-control work; and an investigation of activated sludge phenomena.

Maryland Section

A joint meeting of the Maryland Section and of the Baltimore sections of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers was held at the Engineers Club in Baltimore on April 6. The feature of the occasion was a talk by J. S. Lennox, an engineer of Pittsfield, Mass., on the subject, "A Cure for Unemployment." The prize of $20 offered by the Section for the best paper to be presented by a Junior during 1932 was awarded to Julius Speert for his paper entitled "Design of Sheet Piling Retaining Walls."

Metropolitan Section

The annual meeting of the Metropolitan Section, called to order on May 17, was devoted to a study of the Rockefeller Center Development, popularly known as "Radio City." The speakers were Joseph O. Brown, of the engineering firm of Todd and Brown; John Lowry, Jr., builder of the Music Hall; and O. B. Hanson, manager of technical operations and engineering for the National Broadcasting Company. In general, the engineers engaged on the project found that, in the engineering layout of the buildings, structural demands were given precedence over purely architectural effects. In the radio studios facilities have been provided for the possible practical development of television in the future. The election of officers for 1933–1934 resulted as follows: Thaddeus Merriman, President; Van Tuyl Boughton and D. B. Steinman, Vice-Presidents; Jacob S. Langthorn, Treasurer; and William J. Shea, Secretary. The new directors elected were the following: William W. Brush, Arthur G. Hayden, and Ernest M. Van Norden. After the meeting refreshments were served. The attendance numbered 365.

Milwaukee Section

The Milwaukee Section held a meeting at the City Club on March 22, with 27 members and guests present. After numerous business matters had been attended to, the speaker of the evening, Doswell Gullatt, First Lieutenant, Corps of Engineers, U.S. Army, was introduced. The subject of Lieutenant Gullatt's address, which was illustrated by means of maps and profiles, was "The Proposed Nicaragua Canal."

Panama Section

Members of the Panama Section of the Society and their guests inspected the overhaul activities at the Miraflores locks on March 24. The work now under way is part of the quadrennial program of overhaul of the Pacific locks at Miraflores and Pedro Miguel. The principal item of this year's work consists of the removal of bearings on 12 miter-gate leaves at Miraflores, including the four largest leaves in the Panama Canal.

On April 9 the members of the Panama Section made an inspection trip to Madden Dam. R. M. Conner, who has served as superintendent for the contractors on the construction of the dam, acted as guide for the members. Work on this dam, the largest single project undertaken in the Panama Canal Zone since the completion of the canal, was begun in January 1932.

Philadelphia Section

The annual Student Chapter meeting of the Philadelphia Section was held on April 20, with 89 in attendance at the dinner and 120 at the meeting. After an entertainment provided by the Student Chapters, the speaker of the evening, D. B. Steinman, of Robinson and Steinman, consulting engineers of New York, N.Y., was introduced. Dr. Steinman gave an illustrated address on the subject, "Fifty Years of Progress in Bridge Engineering," which proved of great interest to those present.

Portland (Ore.) Section

There were 38 present at a meeting of the Portland (Ore.) Section, held in the library of the Chamber of Commerce on March 23. After a brief business session, A. L. Alin, Hydraulic Engineer of the Portland District of the U.S. Engineers, gave an interesting illustrated talk on several hydraulic developments.

Puerto Rico Section

On March 11 the Puerto Rico Section held its quarterly meeting in San Juan. The feature of the occasion was the presentation of an interesting paper on "Drinking Water Consumption in Puerto Rico," by Jorge V. Dávila, Engineer in Charge of Water and Sewerage Purification, Puerto Rico Department of Health.

Sacramento Section

The weekly meetings held by the Sacramento Section during the past few months have been well attended. The feature of each of these occasions has been the presentation of a paper or address upon some timely engineering topic. Among the speakers whom the members have thus been privileged to hear are the following: George E. Goodall, Senior Engineer in the Division of Water Resources of the State Department of Public Works; Walter B. Hogan, City Manager of Stockton, Calif.; Joseph W. Gross, Municipal and Reclamation Engineer of Sacramento; and Glenn B. Woodruff, Engineer of Design for the San Francisco Bay Bridge Commission.

San Diego Section

The April meeting of the San Diego Section, held on April 27 at the Churchill Hotel, heard H. A. Noble speak on earthquakes. Mr. Noble discussed earthquake causes, frequency, intensity, and effect on structures.

San Francisco Section

There were 140 members and guests present at a meeting of the San Francisco Section held on February 21. After the usual business session the speaker of the evening, E. C. Eaton, Chief Engineer of the Los Angeles County Flood Control District, was introduced. Mr. Eaton's interesting address on the subject, "Reservoir Detention for Flood Control and Reservoir Retention for Beneficial Use," was illustrated with lantern slides and moving pictures.

Virginia Section

The annual meeting of the Virginia Section was held in Norfolk on March 3, in conjunction with local sections of the American Society of Mechanical Engineers and the American Institute of Electrical Engineers, and the Engineers' Club of Hampton Roads. Included in the routine business session was the election of officers for 1933, which resulted as follows: J. E. Crawford, President; W. D. Faucette, R. Keith Compton, and W. T. Lyle, Vice-Presidents; and P. A. Rice, Secretary-Treasurer. During luncheon Prof. Arthur S. Macconochie, of the University of Virginia, spoke on the subject, "State Engineering Councils," while Prof. Walter S. Rodman, of the same university, discussed "The Engineering Outlook." After an afternoon bus trip to Virginia Beach, dinner was served and other speakers were heard. Among these was C. M. Ripley, of the General Electric Company, whose subject was "New Tools for the New Age."

Student Chapter News

Newark College of Engineering

During the past winter the Newark College of Engineering Student Chapter held several interesting and educational meetings, which were attended by an average of 75 per cent of the Chapter membership. Among those who spoke at these meetings were the following: Edmund R. Halsey, who discussed the subject, "Engineering Ethics"; Lewis C. Hamilton, who lectured on "Triangulation for the Bayonne Bridge"; and Morris R. Sherrerd, contact member for the Chapter, who explained the relationship of the Student Chapter to the Society.

RHODE ISLAND STATE COLLEGE

On March 27 a meeting of the Rhode Island State College Student Chapter was held, with 19 in attendance. The feature of the occasion was an interesting lecture by Carroll D. Billmyer, Assistant Professor of Engineering and Superintendent of Construction, on "The Manufacture of Portland Cement."

UNIVERSITY OF PITTSBURGH

During the first month of the new semester the members of the University of Pittsburgh Student Chapter heard several interesting lectures. Included among the speakers were N. B. Jacobs, of Morris Knowles, Inc., Pittsburgh; A. V. Dolan, in charge of erection for the Fort Pitt Bridge Company; and Winters Haydock, Directing Engineer for the Department of City Transit, City of Pittsburgh.

Appointments of Society Representatives

CHARLES S. GLEIM, M. Am. Soc. C.E., has accepted an appointment as Society representative on the Sectional Committee of the American Standards Association for work on a proposed American Standard Safety Code.

ROBERT RIDGWAY, Past-President Am. Soc. C.E., has been appointed a Society representative to the Division of Engineering and Industrial Research of the National Research Council. The other representatives are RALPH MODJESKI, C. J. TILDEN, and EDWARD H. ROCKWELL, Members Am. Soc. C.E.

American Engineering Council

National representative of 26 engineering societies, with a constituent membership of 60,000 professional engineers, reports civil engineering news of the Federal Government

EXECUTIVE COMMITTEE HOLDS MEETING

The Executive Committee of the American Engineering Council met Tuesday, May 2, in the office of the Executive Secretary, in Washington, D.C. In addition to President W. S. Lee, who presided, the following were present: Vice-Presidents John F. Coleman, Past-President Am. Soc. C.E.; and R. C. Marshall, Jr., L. B. Stillwell, and W. H. Woodbury, Members Am. Soc. C.E.; the chairman of the Finance Committee, A. J. Hammond, President Am. Soc. C.E.; and the Executive Secretary, L. W. Wallace. The committee considered matters of current importance and reviewed the recent activities of the Council in connection with legislative and administrative developments of engineering interest.

Among the matters considered by the committee was a request of the Secretary of Commerce, Daniel C. Roper, relative to Senate Resolution 220, 72d Congress, dealing with detailed estimates of the national income for 1929 and subsequent years. Secretary Roper's request was in part as follows:

> To comply with the Senate request, it is proving necessary to seek the assistance of a number of non-governmental agencies. Data regarding the income of certain professions are now needed and I should appreciate any assistance that you might be able to give our Division of Economic Research in developing adequate income data concerning the engineering profession.

In compliance with this request, the Executive Secretary was authorized to make such studies as necessary to furnish information to the Secretary of Commerce.

The committee considered a bill, H.R. 97, to provide Federal aid for the construction of groins and bulkheads for coast protection. This bill provides for Federal-aid projects for beach protection. The committee voted not to approve the bill because it is not prudent at the present time to ask the states to raise money to match Federal funds for this purpose. In this connection the committee went on record as approving a continuation of the studies of the U.S. Beach Erosion Board.

The committee received and approved the report of the Council's Committee on Patents relative to several patent bills which lapsed with the end of the 72d Congress. Several of these bills have been introduced in the present session and it is expected that the others soon will be. The Council's position on this legislation will be governed by the recommendations adopted. The titles of these bills and the recommendations of the committee are as follows: To support a bill to empower assignee of inventor to file divisional, continuation, renewal, or re-issue application; to disapprove a bill to limit the life of a patent to a term commencing with the date of the application; to approve a bill permitting single signature in patent applications and validating a joint patent for sole invention; to disapprove a bill to abolish the statute permitting renewal of patent applications; to approve a bill to limit inventors to priority of two years before filing applications for patent; to approve a bill to provide a permanent force to classify patents and other work in the Patent Office; to approve a bill to prevent fraud, deception, or improper practice in connection with business before the U.S. Patent Office and for other purposes; and to disapprove a bill to amend the statute relating to patent disclaimers.

The committee considered current legislation dealing with the regulation of foreign securities. The chairmen of all congressional committees having such bills before them have been informed of the attitude of the American Institute of Consulting Engineers on the subject, and the services of the Council in setting up a special committee of engineers to confer with them, if they so desire, have been offered. This matter is now in the hands of Messrs. Stillwell, Coleman, and Wendt, who together with the Executive Secretary were authorized to investigate the matter further to determine in what ways the Council could be helpful.

NATIONAL RELIEF MEASURES

The Administration's relief legislation became law when the President affixed his signature to H.R. 4606 on May 12. Provisions of this legislation of interest to engineers were described on this page in the May issue.

PUBLIC WORKS PROGRAM

On May 17 President Roosevelt submitted a message to Congress calling upon that body to provide the machinery necessary for a great cooperative movement throughout all industry in order to obtain wide reemployment. The President's message included a request for executive power to start a large program of direct employment. He stated his conviction that approximately \$3,300,000,000 could be invested in useful and necessary public works construction and at the same time put the largest possible number of people to work, and indicated that means must be found to raise an additional \$220,000,000 of revenue to defray the interest and amortization charges in connection with the proposed expenditures for public works.

Coincident with the presentation of the President's message to Congress, Senator Wagner introduced a bill, S. 1712, to encourage national industrial recovery, to foster fair competition, and to provide for the construction of certain useful public works. Title I of this bill deals with provisions for the organization of industry for the purpose of cooperative action among trade groups. Title II is devoted to a program of public works and construction projects. It authorizes the President to create a Federal Emergency Administration of Public Works, the powers of which shall be exercised by a Federal Emergency Administrator of Public Works. The administrator, without regard to Civil Service laws, may appoint and fix the compensation of such experts and other officers and employees as are necessary in carrying out the provisions of Title II. The powers of the administrator will expire after a period of two years, or sooner if the President proclaims that the present emergency is ended.

The Federal Emergency Administration of Public Works is directed to prepare a comprehensive program of public works which shall include: (1) the construction, repair and improvement of public highways and parkways, public buildings, and any publicly owned instrumentalities and facilities; (2) the conservation and development of natural resources, including control, utilization, and purification of waters; prevention of soil erosion; development of water power; transmission of electrical energy; and construction of river and harbor improvements; (3) any other projects of the character normally constructed or carried on either directly by public authority or with public aid, to serve the interests of the

general public; (4) the construction under public regulation or control of low-cost housing and slum clearance projects; and (5) any other project of a character now eligible for loans under the Emergency Relief and Construction Act of 1932, as amended.

The act also provides, at the discretion of the President, for the construction of naval vessels, airplanes, Army housing projects and equipment, and mechanization or motorization of Army units.

The act authorizes the President: (1) to construct, finance, or aid in the construction or financing of any public works project included in the program to be prepared by the Federal Emergency Administration of Public Works; (2) to make grants to states, municipalities, or other public bodies for the construction, repair, or improvement of any project on such terms as he may prescribe up to 30 per cent of the cost of the labor and materials employed on any such projects; (3) to acquire by purchase or by exercise of the power of eminent domain any real or personal property in connection with the construction of any such project, and to sell any security acquired or any property so constructed or acquired or to lease any such property with or without the privilege of purchase; (4) to aid in the financing of such railroad maintenance and equipment as may be approved by the Interstate Commerce Commission as desirable for the improvement of transportation facilities.

The bill provides for the emergency construction of public highways and related projects and authorizes the President to make grants to the several states not to exceed $400,000,000 in aggregate, for the expenditure for emergency construction on the Federal Aid Highway system and its extensions into and through municipalities. The amount apportioned to any state for this purpose may be used to pay all or any part of the cost of highway construction, including the elimination of hazards to highway traffic, such as the construction or reconstruction of grade separations at highway and railroad crossings. It also provides for expenditures in emergency construction on secondary or feeder roads to be agreed upon by the state highway departments and the Secretary of Agriculture.

In connection with the provisions for grants for highway purposes, the bill outlines the method of apportionment to the states and removes certain restrictions that in the past have applied to Federal-aid highway work, such as the necessity of matching Federal grants with state funds and limits as to payments per mile from Federal funds.

The bill authorizes the appropriation, out of any money in the Treasury not otherwise appropriated, of $3,300,000,000 to defray the costs of the work contemplated and provides for the issuance of bonds, notes, certificates of indebtedness, or Treasury bills of the United States to meet the costs of the work. Title III of the bill amends the Emergency Relief and Construction Act of 1932 to provide that after the expiration of ten days after the date on which the administrator is qualified and takes office, no application shall be approved by the Reconstruction Finance Corporation.

For several weeks prior to the introduction of this bill, the American Engineering Council and the American Society of Civil Engineers made concerted efforts to include funds for an expansion of Federal surveying, mapping, and water resources investigation activities. Statistics gathered from the Federal agencies involved indicated the possibility of expending $10,000,000 for useful work of this character within the next fiscal year if funds were made available. As drafted, the bill makes no specific reference to these activities but it appears that such activities should properly be considered as included under certain of the provisions of the bill.

Efforts to include surveying, mapping, and water-resources investigation activities have continued unabated. Statistics gathered from the Federal agencies involved indicate the possibility of expending $10,000,000 for useful work of this character within the next fiscal year, if funds are made available. Through the courtesy of the American Society of Civil Engineers, Ralph J. Fogg, M. Am. Soc. C.E., formerly Professor of Civil Engineering at Lehigh University, has been devoting his time to assisting the Council in its efforts to further this phase of the program.

Other phases of the public works program are as yet undetermined. Legislation relative to amending the Emergency Relief and Construction Act of 1932 appears to be held in abeyance. In all probability the final disposition of such measures will depend upon the direction in which the major public works program moves.

Federal Research and Technical Activities Threatened

Due to the Administration's determination to reduce drastically the operating costs of the Federal Government for the fiscal year 1934, it has appeared possible that many important Federal services will not have sufficient funds to perform their functions in a manner consistent with the public welfare. This danger is especially imminent in connection with many of the scientific services.

The Engineering Council has directed its efforts to calling to the attention of those in authority the unfortunate results that would follow an indiscriminate reduction of these services without regard to their usefulness. In this connection, the inadvisability of severely curtailing the activities of the Bureau of Agricultural Engineering has been pointed out. The research work of this bureau is of great value in conjunction with alleviating the present agricultural distress.

The Council has also indicated the engineering profession's interest in the activities of the Weather Bureau. It has requested that in arriving at any plans to limit the scope of this Federal agency, careful thought be given to the dependence which engineers place on the data collected by the bureau. Attention was called to the recent report of the Society's Committee on Meteorological Data, which clearly indicates the way in which the Weather Bureau can be of great service to the engineering profession.

Retirement of Federal Employees

On April 19, 1933, the Director of the Budget, in submitting to the President estimates of appropriations for the Executive Office and independent establishments for the fiscal year 1934, recommended legislation which would require that those Federal employees with 30 or more years of service be automatically retired. It was proposed that this legislation be so framed as to enable the President to exempt any person when in his judgment the public interest so required.

The American Engineering Council joined in the vigorous protest which this proposal evoked. In a letter addressed to those members of Congress charged with drafting the appropriation bill the injustice of such an arbitrary plan was pointed out and the hardship it would work on technical services of the Government. In many cases a technical man does not reach a high degree of professional attainment until after 30 or 40 years of experience and neither age nor length of service is a correct or fair criterion of the usefulness of such men.

As a result of the many objections raised to the proposal of the Director of the Budget, the appropriation bill as drafted does not include the provisions he recommended. In their place has been substituted authority to furlough officers and employees without pay so as to distribute so far as practicable the work available. Such furloughs are not to exceed 90 days in the fiscal year 1934.

St. Lawrence Waterway Treaty

The ratification of the St. Lawrence Waterway Treaty has been called on the Senate Calendar several times, but in every case its consideration has been postponed. Indications are that this postponement will continue and that no consideration will be given to this matter during the present special session of Congress.

Congress to Amend Interstate Commerce Act

The Administration has introduced in both houses of Congress legislation to relieve the existing national emergency relative to interstate railroad transportation, and to amend Sections 5, 15A, and 19A of the Interstate Commerce Act, as amended. These bills, when enacted, will be cited as the Emergency Railroad Transportation Act of 1933.

Title I of the bill provides for emergency powers with which the Administration will deal with the railroad problem. Title II relates to amendments to the Interstate Commerce Act, including provisions for repealing the Recapture Clause and for distributing the funds that have been impounded under the provisions of the present act. The bill also provides for amendments to those sections of the act dealing with railroad valuations by the Interstate Commerce Commission. These provisions are identical with similar legislation introduced by Mr. Rayburn in the House of Representatives during the 72d Congress. At that time the Council voted to approve these amendments to the Interstate Commerce Act. Arrangements are being made to place the Council's views on this subject before the congressional committees that will consider the pending legislation.

May 17, 1933

ITEMS OF INTEREST

Engineering Events in Brief

Civil Engineering for July

Danish engineers are completing a combined railroad and highway bridge connecting Fyen, one of the largest of the Danish islands, with the Jutland Peninsula, on which a third of the population of Denmark live. The over-water part of the bridge is divided into five spans, the longest being 722 ft, and the approach structures consist of high concrete arches. A very comprehensive article by Adolf C. Davids, Assoc. M. Am. Soc. C.E., and Andreas Mortensen, of the Danish State Railways, to appear in the July issue, explains the reasons for adopting each feature of the design.

One of the Freeman Scholars now in Europe, Donald M. Barnes, Jun. Am. Soc. C.E., has submitted an interesting report on current experimental work in hydraulics being conducted at the Technical University of Berlin. These researches include the subjects of uplift under dams and the hydraulic drag of water running through pipes.

In constructing the east approach to the George Washington Bridge three girders 120 ft long and weighing 70 tons, a part of the steel supporting the portal to the tunnel under 178th and 179th streets, were handled by truck in one piece from the railroad to the work. How the contractors manipulated these unwieldy members through some of Manhattan's narrow streets, on considerable grades, and hoisted them into place is to be told by W. G. Rapp, Assoc. M. Am. Soc. C.E. The article is an interesting commentary on the ingenuity of the hauling contractor and the steel erector.

At Lehigh University tests have been made on concrete columns to determine the extent to which a large percentage of longitudinal steel increases the strength of a column and the effect of varying percentages of spiral reinforcement. The results are enlightening and suggest the use of high yield-point steel for longitudinal bars in certain cases. The tests, conducted by Inge Lyse, M. Am. Soc. C.E., and reported by him, are in a sense supplementary to the series reported by Committee 105 of the American Concrete Institute in the *Journal* of the Institute for 1930, 1931, and 1932.

Nassau, the capital of the Bahamas, derives its domestic water supply from a battery of ninety wells situated on the south slope of the Blue Hills three and a half miles south of the city. Because of the porous nature of the island's geologic structure, the ground-water level as measured in wells fluctuates with the tides. When the wells are over-pumped they become saline. An article by J. Ormond Riddel develops a theory based on the results of pumping on the island that will serve as a guide for the operation of wells similarly located.

A Monument to Surveying

By Paul P. Rice

Junior, American Society of Civil Engineers
Instructor in Civil Engineering, Lafayette College, Easton, Pa.

The memorial to the Pennsylvania State Legislature, drawn in 1824 by those interested in founding a college in Easton, Pa., contained these important sentences: "Civil engineering has of late become a very prominent branch of education, and what is remarkable, not a college in our country (if we are correctly informed) has made it a part of their course. This important branch of knowledge will be most thoroughly taught [in the proposed college]." So far as we are able to learn, this proposal for a college course in civil engineering occurs here for the first time in American history.

Triangulation Station "Centennial," at Lafayette College
In the Rear, the Commemorative Stone and Plaque Dated 1932

As the first century of the existence of the college was being completed and plans were going forward for the centennial celebration, the Department of Civil Engineering deemed it fitting and proper that it should honor the memory of its founders and in some small measure emulate their extraordinary vision and foresight. Although the dream of the founders in establishing a department of civil engineering was not realized until 1866, the earliest existing records and documents show that surveying was a course offered and given from the beginning. Since that time parts of the campus have been surveyed many times, to the displeasure of the ground keepers.

There exists in our country today a very great need for surveys based on triangulation control and also a need for permanent and accurately set monuments or landmarks delineating our various boundaries and corners. It was therefore deemed fitting that the Department of Civil Engineering should honor the founders by undertaking a triangulation survey of the college campus, placing at each station, bench mark, and property-line corner a standard, well designed, and permanent monument, and also by plotting a large-scale topographic map of the campus whereon the construction of the past century could be plotted and detailed studies made for the future. Advice was secured from R. S. Patton, M. Am. Soc. C.E., Director of the U.S. Coast and Geodetic Survey, concerning monument construction. One hundred brass plates or disks, 30 for triangulation stations and 70 for property-line monuments, were purchased. These are identical in shape and design, except for lettering, with those now used by the Coast Survey. A heavy collapsible steel form with necessary fixtures for centering the plate and holding reinforcing wires in place was constructed. Sixty monuments have now been cast, of which 20 have been set up on the campus.

To the memory of the founders; to the purpose of setting before the student civil engineers an example of fine landmark construction; to the aim of instilling in the student body a reverence and respect for landmarks; and to the vision that we may some day see all our corners designated by permanent markers and our surveys connected with the triangulation of the U.S. Coast and Geodetic Survey, the first triangulation station and bench mark at Lafayette College was dedicated on May 9, 1932, with appropriate exercises. The accompanying illustration shows the first monument set and the plaque, bearing the inscription:

1932
THE FIRST TRIANGULATION
STATION AND BENCH MARK

Dedicated May 9, 1932, on the
One Hundredth Anniversary of
the Opening of the College

A Primary Reference Point
for Surveying, Mapping and
Planning the Second Century
of Our Progress

Engineering Our Way Through

A Radio Appeal in Behalf of Unemployed Engineers

By W. A. Shoudy

Executive Chairman, Professional Engineers' Committee on Unemployment, New York, N.Y.

In the campaign to find work for unemployed engineers in New York and vicinity, Professor Shoudy recently made an appeal over a nation-wide radio hook-up. In the belief that the idea may prove useful in other communities, the gist of the address is given here.

No one thus far has materially improved Tredgold's definition made in 1827, when he called engineering "the art of directing the great sources of power in nature for the use and convenience of man." He whose vocation meets this specification is a member of this great profession, no matter by what path he has come.

The path for most engineers has been years of study and apprenticeship, but many of the greatest engineers have been self-taught and self-trained; in fact, the foundations upon which civilization is now building were laid by men not known as engineers but distinguished from their fellows only by their wider knowledge of the natural sciences and their ability to reason from facts to new structures, machines, or processes. The Egyptian pyramids, the Grecian temples, the Roman roads and aqueducts, are the products of the engineering mind, and even the Gothic arches of Europe's medieval cathedrals are examples of the highest engineering skill.

One of the Oldest Professions

Engineering is not a new profession; it is one of the oldest. But for the last one hundred and fifty years it has become increasingly important, until now it enters into almost every daily activity of every human being.

We rise in the morning and take our shower with water provided by the civil engineer, through piping of metals provided by the mining engineer, and manufactured by machines designed by the mechanical engineer. Our breakfast is cooked by heat provided by many engineers. We go to our daily task over roads built by the civil engineer with road machinery built by the mechanical engineer, and in vehicles designed by electrical and mechanical engineers. Our shops, our office buildings, our elevators, our typewriters, our pens, pencils, and paper are all engineering products, and when we turn on the light or answer the telephone we are in debt to the engineer for these services.

Even our hours of relaxation are dependent on the engineer. The presses that print our books are one of the finest examples of mechanical engineering skill, and the electrical engineer has given us our radio, our movies, and the beautiful lighting effects of the modern theater.

We go to bed with a feeling of security, because the telephone near our pillow will bring the doctor, the police, or the fire department when help is needed. When the electric clock awakens us in the morning, our electric thermostat will have opened the furnace drafts and taken away the chill of the night.

Rapid discoveries in the field of the sciences put new tools in the engineers' hands, and the development of the machine shop, the steam engine, and other means of transportation created new industries and new problems for engineering study. The fields broadened so rapidly that no one man could be expert in all, and in self defense new classifications were established. The civil engineer preferred to let the mechanical engineer develop the locomotive, so long as the former could continue to build the roadbeds. The mechanical engineer was content to design the machine if the mining engineer would furnish the metals, and the electrical engineer the motors. Rapidly other branches appeared, and at times even professional jealousies reared their ugly heads. But nature abhors arbitrary classifications; never can there be found distinct lines of demarcation, but rather there is an overlapping of interests. Each engineer now has his specialty, some easily labeled, but generally a mixture of all branches.

To construct and operate a single power station requires some knowledge of mechanical, electrical, structural, foundation, hydraulic, sanitary, and—at times for load dispatching—even radio engineering. If the plant is to be a financial success one must know the elements of economics, accounting, and industrial management, and the purchase of fuel will be aided by familiarity with mining methods. Any large project has just as wide a diversity of problems, yet each has one branch that predominates and labels it.

Forget the label and think only of the engineer without the qualifying adjective. Does he today fulfil the specifications of Tredgold's definition? Yes, and he has added one item implied by Tredgold but not specifically stated. Today he is vitally concerned with money. He is often called an expense, but it is more accurate to call him a watch dog of the treasury.

Economist and Accountant

No engineer can be proud of his work if it is a financial failure, nor can he point with pride to his latest achievement if there was a cheaper way to accomplish the result. He has been forced to add economics and accounting to his studies, and it is his profession which initiated, and is leading, the development of the science of industrial management.

Modern life is a network of engineers' activities. That type of man and that sort of training, call it what you will, is indispensable to the civilization of today. Remove him, and communication, light, and heat will fail; our large cities will be short of food in a week, and of milk in a day.

In this highly mechanized country of one hundred and twenty million people, it would be expected that there would be a very large number of engineers, but the best interpretation of the census records shows hardly more than two hundred thousand. Undoubtedly there are many who are not so classified. Doubling this number, for good measure, it is found that less than four-tenths of one per cent of the country's population can be classed as engineers—and this in the most highly mechanized country in the world.

Many engineers felt this depression before it arrived but thought the halt was temporary. After the market crash they were possibly the first to suffer. The smaller the community or industry, the quicker the ax fell. No one knows accurately how many engineers are now unemployed, but one of the national engineering societies has made a careful analysis of its membership and finds that fully one-half are totally without work; others are on part time; and all others are suffering from reduced earnings. The non-payment of dues indicates a like condition in other societies. This curtailment of the societies' income is reducing the number of engineering meetings and papers, and their work in engineering research has almost ceased.

Engineers Help Their Fellows

The four large national engineering societies, generally known as the Founder Societies, are taking financial care of their embarrassed brothers. Their local organizations throughout the country, in cooperation with established agencies, are providing food, clothing, and money for all those in actual want as fast as such cases are discovered. The funds are provided by donations from the members of the engineering societies in the respective communities. The engineers of Boston have developed an extensive program of municipal improvements; those of Rochester have thrown their efforts in with the unemployment committees of that city; those in New York have spread their activities to include all within a radius of 50 miles and have a corps of men canvassing this area each day hunting for jobs. The records of the Professional Engineers' Committee on Unemployment give each unemployed engineer's experience in detail. By return mail a man can be recommended for any opening. Through nation-wide connections a man can be found in almost any part of this great country.

The engineer, like any other self-respecting man, does not want charity, nor is he looking for a large income. He wants to provide the bare necessities of life for his family, but most of all he wants a problem to solve.

In spite of the large volume of made work being carried on in many of our cities, unemployment among engineers seems to be increasing. These valuable minds must be kept active or, as times improve, there will be a shortage of the

technical skill that is so important to every citizen's daily welfare.

The engineer has been in such great demand during the past generation because of his technical skill, that the value of his analytical mind has been overlooked when applied to problems not highly technical. But the public is slowly realizing his value in other lines. New York City is finding him valuable as a building manager or superintendent. One engineer preferred to drive a laundry truck than to depend on charity. Then he began to keep the books at night, and by force of habit analyzed the costs and soon located the reasons for the red ink. His knowledge of human nature helped him to study his customers. He has not only stopped the losses but has increased the volume of the business. An engineer has been lost to the profession, but a laundry has gained an efficient manager.

Another engineer has developed a method of cleaning tombstones without injury to them and now has eight assistants. Another has cut a factory's coal bill in half; another has reduced the manufacturing cost of a standard product by three-quarters; and still another has produced a unique and inexpensive coffee table—but why go on?

You may have a problem that needs a fresh mind. Call in the engineer. Pay him a salary if you can, for he is very short of cash, but if you cannot, pay him a fair fee when he gives you the answer. Engineers will take a gamble if the cards are not stacked. They are not afraid of manual work, for they went through it in their apprenticeship and often return to it for their relaxation.

Give the engineer a chance to help you. He will return more to you than you pay him or he will not want the job. He will probably create new jobs for others, for, remember, the engineer has created a hundred-fold more jobs than he has eliminated.

Stop thinking of him as a man interested only in technical problems, but rather regard him as a man with a highly trained, analytical mind whose joy in life is that of solving problems for others. He has created most of the industries of this country and has been satisfied with this contribution to civilization rather than with large monetary rewards. He has new industries waiting for development, which will create new jobs for other men. These one hundred thousand men who are now out of employment, if put back to work, may be the men who will bring back prosperity to this country.

For thirty years the engineer has not had to hunt for opportunities, and has lost skill in job hunting. Tell him your problems and let him help you back to prosperity!

Balancing Economic Forces

TWO YEARS AGO the American Engineering Council assigned to its Committee on Relation of Consumption, Production, and Distribution the problem of selecting and recommending such governmental, financial, and business policies as will maintain in the United States a standard of living that is high, broadly distributed, and free from severe fluctuations. The committee's first progress report, which was released in February 1932, resulted in the collection of over 200 reviews, offered by eminent men engaged in a wide range of business and professional activities, and a file of more than 50 suggested remedial plans. With this wealth of material at hand, the committee prepared its second progress report, which was submitted to the Council in January 1933.

The second report is divided into two parts: an analysis of 40 alleged causes of business instability, classified as primary, contributory, incidental, or doubtful; and an analysis of the theories, principles, and methods of a selected group of 23 of the 50 plans offered to prevent, or to minimize, the effects of business recession. Considering the problem from these points of view, the committee believes that perfect business stability, or a near approach to it, cannot be attained. However, a rise in the scale of living is physically possible to a degree little comprehended by those unfamiliar with the available productive processes and organizations. A better distribution of goods—that is, more to classes enjoying few or almost no goods—is now physically attainable without any substantial diminution in the share of those rendering useful service.

Numerous causes for economic instability are set forth in this second progress report. In Part I, the committee has grouped in seven general classes the 40 causes that have come to its attention. These classes are: psychological, technological, business performance, savings and investment, financial, agricultural, and governmental. Each of these causes has been analyzed for the purpose of determining its effect on business stability, scale of living, and unequal distribution of goods. The single finding that the committee is willing to support as a result of its investigations is that no one, all-conclusive cause can be assigned as the forerunner of a business depression, nor can an all-inclusive remedy be found as a cure or preventative. The problem of economic and social control is of such magnitude that its solution will be a major event in the history of civilization.

In analyzing the 23 plans for business stabilization in Part II of its report, the committee expressed no opinion, favorable or unfavorable, regarding any of them. They are presented to show the type and quality of thinking that is being given to the problems of business instability and to indicate suggested remedies or cures.

Although only a limited number of copies of the original report have been prepared, the report has been published practically in its entirety in *Mechanical Engineering*, of the American Society of Mechanical Engineers, Part I in the April issue and Part II in May. The report is signed by R. E. Flanders, Chairman; L. P. Alford; F. J. Chesterman; Dexter S. Kimball; F. H. McDonald, M. Am. Soc. C.E.; L. W. Wallace; and W. J. Wilgus, M. Am. Soc. C.E.

NEWS OF ENGINEERS

From Correspondence and Society Files

J. CHÁVEZ-OROZCO has been appointed Construction Manager of the Rodriguez Dam, Tijuana, Baja California, which is now being completed by the National Irrigation Commission of Mexico. He was formerly an engineer with the J. G. White Engineering Corporation, of Mexico City.

HARRY J. ENGEL has accepted a position with Modjeski, Masters and Chase on the Mississippi River Bridge, with headquarters in New Orleans, La. Previously he was employed by the Electric Railway Presidents Conference Committee, of Brooklyn, N.Y.

KENNETH H. DAVIS has resigned his position as Chief Engineer of the Western Steel and Wire Company, Ltd., of San Francisco, Calif., to become President of the Standard Wire Corporation of California, with headquarters in South San Francisco.

H. A. HUNTER has resigned as sales engineer for the Northern Pump Company, of Minneapolis, Minn., to rejoin the staff of Hawley, Freese, and Nichols, consulting engineers of Fort Worth, Tex., with whom he was previously associated.

GEORGE E. WARREN has been promoted from the position of Assistant General Manager of the Portland Cement Association, in San Francisco, Calif., to that of Vice-President of this organization and manager of its Eastern operations.

ERNST LIEBERMAN, formerly of Lieberman and Hein, of Chicago, Ill., has accepted a position as Chief Highway Engineer with the State of Illinois Department of Public Works and Buildings, in the Division of Highways. He will be located in Springfield.

HERBERT NUNN has severed his connection as engineer with the California Standard Oil Company de Mexico, City of Mexico, to become an engineer in the sales department of the American Bitumuls Company, with headquarters in Albany, N.Y.

R. P. BRYAN has been made Engineering News Editor of *Western Construction News*, with offices in Los Angeles, Calif. Previously he was with the Morrison, Knudsen Company of Fort Washakie, Wyo.

R. F. HOFFMARK, formerly Vice-President of A. Guthrie and Company, Inc., of Portland, Ore., has been appointed General Manager of Woods Brothers Construction Company of Lincoln, Nebr.

EDWIN H. EATON has taken a position with the George H. Flinn Corporation, of Elmhurst, Long Island, N.Y., as Assistant Engineer.

CELSO A. GARCIA has entered the employ of the Plata Sugar Company, Inc., of San Sebastian, Puerto Rico, in the capacity of Civil Engineer and Field Manager.

RICARDO FERNANDEZ PERALTA has accepted an appointment as Inspection Engineer of the municipal works of the City of San José, Costa Rica. Previously he was Chief Engineer for the Comisión Especial de Pavimentación y Saneamiento, of San José.

JAMES E. GIBSON has established the consulting engineering firm of James E. Gibson, Inc., of Charleston, S.C. This organization will specialize in water works, sewerage, appraisals, and allied fields.

J. E. WHEELER, formerly of Ronceverte, W. Va., has accepted a position with the Independent Bridge Company, with headquarters in Pittsburgh, Pa.

HERMAN M. BRALOFF has resigned his position with the Corson Construction Corporation, of Brooklyn, N.Y., to become Vice-President of the Brader Construction Corporation, of New York, N.Y.

GEORGE D. COWIE has been advanced from the rank of Lieutenant in the U.S. Coast and Geodetic Survey to that of Hydraulic and Geodetic Engineer, in charge of the New York Field Station of the Survey, with headquarters at 6 State Street, New York, N.Y.

Changes in Membership Grades

Additions, Transfers, Reinstatements, Deaths, and Resignations

From April 8 to May 9, 1933, Inclusive

Additions to Membership

ADAMS, LAWRENCE FREDRIC (Jun. '33), 496 Sanford Ave., Newark, N.J.

AFRICANO, ALFRED (Jun. '33), Asst. Engr., Interborough Rapid Transit Co., New York, N.Y. (Res., 4246 Hudson Boulevard, Union City, N.J.)

ATTRIDGE, WILLIAM JAMES (Jun. '32), Rigby, Idaho.

BALDWIN, EDWARD WILLIS, JR. (Jun. '33), 331 South 2d St., De Kalb, Ill.

BAYLISS, LAWRENCE ALFRED (Jun. '32), 3921 Bettinger St., Hawthorne, Calif.

BERNSTROM, CARL GUSTAV (Jun. '32), 1417 First St., Rensselaer, N.Y.

BOBISCH, WILLIAM JULIUS (Jun. '33), 6137 Giddings St., Chicago, Ill.

BOGART, DEAN BUTLER (Jun. '32), 190 Thomas St., Bloomfield, N.J.

BOLINAS, ANDRÉAS, JR. (Assoc. M. '33), Civ. Engr., Surv., and Contr., Box 50, Legaspi, Albay, Philippine Islands.

BUSALACCHI, JOSEPH MICHAEL (Jun. '33), 3306 North Oakland Ave., Milwaukee, Wis.

DENNIS, RICHARD WHITING (Jun. '33), 220 South Van Ness Ave., Los Angeles, Calif.

DERISO, WALTER CARL (Jun. '32), 4605 Hudson Boulevard, North Bergen, N.J.

ENNIS, CHARLES WILBUR, JR. (Jun. '33), 1133 West Pierce St., Houston, Tex.

FERRÉ, HERMAN (Jun. '33), Asst. Engr., Design Dept., Porto Rico Iron Works, Inc. (Res., 13 Leon St., Ponce), Puerto Rico.

FOLEY, WILLIAM EDWARD (Jun. '32), 539 Thames St., Newport, R.I.

FONT, GILBERTO MELQUIADES (Jun. '32), Box 156, Aibonito, Puerto Rico.

FREYBERG, WOLDEMAR OSCAR (M. '32), Research Engr., Eng. Research Dept., Univ. of Michigan (Res., 1125 Olivia Ave.), Ann Arbor, Mich.

GRAZULIS, ALBERT CHARLES (Jun. '31), 11 West 28th St., Bayonne, N.J.

HIGGS, GEORGE, JR. (Jun. '32), 11 Washington St., Marblehead, Mass.

HUNT, OLIVER PARKS (Jun. '32), Freehold, N.Y.

HUTCHISON, ALFRED DREBEL (Assoc. M. '33), Res. Engr., State Highway Dept., Marshall, Tex.

KAHAN ARTHUR (Jun. '32), 67 Meserole St., Brooklyn, N.Y.

LEVANTINE, LEO BURTON (Jun. '32), 635 West 174th St., New York, N.Y.

MACSWAIN, HAROLD CLARKE (Jun. '33), 1025 Crescentwood Rd., East Lansing, Mich.

MORT, LINWOOD GEORGE (Jun. '32), 11 East Main St., Jewett City, Conn.

ROOT, LLOYD EUGENE (Jun. '33), 7 Franklin St., Annapolis, Md.

SCHMIDT, GEORGE EDWARD (Jun. '32), Chainman and Rodman for Onondaga County, Pompey, N.Y.

SKAU, GORDON GEORGE (Jun. '33), Junior Engr., Board of Transportation, New York (Res., 6831 Ridge Boulevard, Brooklyn), N.Y.

SMITH, LEWIS GORDY (Jun. '32), 1171 Glenwood Boulevard, Schenectady, N.Y.

SPELL, WILLIAM ARTHUR (M. '33), Chf. Engr., A. B. & C. R. R., 26 Cain St. (Res., 685 Grady Pl., S.W.), Atlanta, Ga.

STONE, CHARLES ALFRED (Jun. '32), 120 West 10th St., Kansas City, Mo.

URBANTKE, MARVIN HUGO (Jun. '32), 1202 Willard Ave., Houston, Tex.

WYLIE, MARSHAL JESSE (Jun. '32), Box 1148, Gallup, N.Mex.

Membership Transfers

ALBRIGHT, RALPH JOHN (Jun. '29; Assoc. M. '33), Estimator and Designer, McClintic-Marshall Corporation, Bethlehem (Res., 233 North Hall St., Allentown), Pa.

ANDERSON, NORVAL EUGENE (Assoc. M. '27; M. '33), Senior Civ. Engr., The San. Dist. of Chicago, 910 South Michigan Ave., Chicago (Res., 618 South Catherine Ave., La Grange), Ill.

ARANIBAR, ERNESTO (Jun. '24; Assoc. M. '32), Acting Mgr., Bolivian Office, The Foundation Co., Casilla 557, La Paz, Bolivia.

COLBURN, ROBERT TALBOT (Jun. '24; Assoc. M. '33), Structural Engr. and Designer, Forstmann Woolen Co., (Res., 145 Elmwood Ave.), Passaic, N.J.

FINEREN, WILLIAM WARRICK (Assoc. M. '09; M. '33), Cons. Civ. Engr. and Asst. Prof., Mech. Eng., Univ. of Florida, Gainesville, Fla.

HAINOVSKY, NICHOLAS JOHN (Jun. '28; Assoc. M. '32), 2 West 120th St., Apartment 70, New York, N.Y.

HARDER, ERNEST HENRY (Assoc. M. '18; M. '33), Senior Bridge Engr., State Highway Dept., Bridge Div., Newark (Res., 80 Kenwood Pl., East Orange), N.J.

HOERNER, CHARLES GOTTLOB, JR. (Assoc. M. '18; M. '33), Section Engr., Board of Water Supply, New York (Res., 1079 East 42d St., Brooklyn), N.Y.

KELLY, EUGENE THOMAS (Jun. '29; Assoc. M. '33), Junior Engr., New York and Queens Elec. Light & Power Co., Flushing (Res., 76-66 Austin St., Apartment 2-0, Forest Hills), N.Y.

MOOREHEAD, THEODORE PARKER (Assoc. M. '09; M. '33), Port Manager, Bhavnagar, Kathiawar, India.

NORRIS, MILTON SADTLER (Jun. '27; Assoc. M. '33), Engr., Cunningham Foundation Co., Pittsburgh, Pa. (Res. 2129 North Charles St., Baltimore, Md.)

POLLEY, EDWARD RICHARD (Assoc. M. '26; M. '33), Vice-Pres., Fairchild Aerial Surveys, Inc., 224 East 11th St., Los Angeles, Calif.

TRIANA, JORGE (Jun. '19; Assoc. M. '25; M. '33), Apartado 5, Bogota, Colombia.

VAN GOENS, EDWIN (Jun. '26; Assoc. M. '33), Topographical Draftsman and Junior Civ. Engr., Sewer Dept. (Res., 633 North Mariposa Ave.), Los Angeles, Calif.

Resignations

BERRY, GUY NEILL, Assoc. M., resigned May 2, '33.

DOWNIE, EDWARD JAMES, Assoc. M., resigned Apr. 17, '33.

FISHER, HARRY BENJAMIN, M., resigned Apr. 28, '33.

HECHT, MAURICE ALBERT, Jun., resigned Apr. 17, '33.

KULKA, ERNST ROBERT HANS, Assoc. M., resigned Apr. 17, '33.

MITCHELL, ADOLPHUS, Jun., resigned Apr. 27, '33.

WALTON, ALEXANDER YOUNG, Assoc. M., resigned Apr. 12, '33.

Deaths

BREIDERT, HENRY CYRILLE. Elected M., Sept. 2, 1914; died March 14, 1933.

CAMERON, HARRY EZRA. Elected M., Oct. 13, 1923; died March 13, 1933.

CHAPMAN, RONALD FARQUHAR. Elected Assoc. M., March 11, 1919; died Feb. 24, 1933.

DONALD, CHARLES STEWARD. Elected Assoc. M., Oct. 15, 1923; died Dec. 9, 1932.

DOUGLAS, EDWARD MOREHOUSE. Elected M., Dec. 4, 1901; died July 1, 1932.

GRIFFIN, JOHN ALEXANDER. Elected Assoc. M., Jan. 3, 1911; died April 12, 1933.

JOYNER, FRANK HALL. Elected M., Sept. 5, 1911; died April 11, 1933.

KERCH, WALTER WASHINGTON. Elected M. Aug. 30, 1926; died April 13, 1933.

LINK, JOHN WILLIAM. Elected M., Nov. 12, 1913; died April 14, 1933.

MCCLINTOCK, JAMES ROBINSON. Elected Jun., Oct. 2, 1906; Assoc. M., May 3, 1910; M., June 24, 1914; died April 11, 1933.

MILLER, LEE HAUN. Elected Assoc. M., Jan. 31, 1911; M., Oct. 15, 1923; died April 9, 1933.

NEWMAN, JEROME. Elected M., Jan. 7, 1913; died April 30, 1933.

ROBINSON, JOHN WALTER. Elected Assoc. M., Oct. 1, 1928; died March 2, 1933.

STRACHAN, ROBERT CHARLES. Elected M., Aug. 31, 1900; died April 16, 1933.

TOTAL MEMBERSHIP AS OF MAY 9, 1933

Members	5,800
Associate Members	6,317
Corporate Members	12,117
Honorary Members	18
Juniors	2,979
Affiliates	113
Fellows	5
Total	15,252

Men Available

These items are from information furnished by the Engineering Societies Employment Service, with offices in Chicago, New York, and San Francisco. The Service is available to all members of the contributing societies. A complete statement of the procedure, the location of offices, and the fee is to be found on page 97 of the 1933 Year Book of the Society. To expedite publication, notices should be sent direct to the Employment Service, 31 West 39th Street, New York, N.Y. Employers should address replies to the key number, care of the New York Office, unless the word Chicago or San Francisco follows the key number, when the reply should be sent to the office designated.

Construction

Superintendent of Construction; M. Am. Soc. C.E.; experienced in bakery and brewery construction, handling all physical problems for either the owner's end or contractor's; able to take complete charge. C-7840.

Civil Engineer; Jun. Am. Soc. C.E.; 28; single; graduate engineer; 8 years experience, field and office work, on reinforced concrete and steel construction of bridges, buildings, industrial plants, including 3 years responsible experience on surveys, design of concrete, steel and machinery, appraisals, and tests. Available immediately. Location immaterial. D-2134.

Construction Engineer and Superintendent; M. Am. Soc. C.E.; 52; married; graduate civil engineer; 25 years experience; 15 years in responsible charge of highway bridges and grading, railroad bridges, grading, tracklaying; 6 years on outstanding sanitary drainage and sewerage projects; qualified to assist in estimates and do all ordinary field designing. Available immediately. Location immaterial. D-2135.

Engineer; Jun. Am. Soc. C.E.; 23; single; 2 years experience, including general construction, concrete and concrete aggregate inspection, highway work, surveying. Resourceful, dependable, and capable of taking responsibility. Desires position with construction company as assistant to, or under supervision of, older, experienced engineer or construction superintendent. Available at once. No preference as to location. D-2087-334-A-3, San Francisco.

Design

Bridge Engineer; Assoc. M. Am. Soc. C.E.; 36; married; graduate; registered professional engineer; over 14 years varied experience in designing, estimating, and construction of bridges and highways; 5 years in charge of design of bridges for large highway program; competent to assume responsibility. Available now. No preference as to location. D-2111-334-A-4, San Francisco.

Industrial Engineer; M. Am. Soc. C.E.; graduate; licensed. Over 20 years experience in design and fabrication of structural steelwork for all classes of structures; design and construction of industrial plants, hydro-electric developments, industrial housing groups, commercial garages, and service stations, etc. Specifications for materials and equipment, obtaining bids, letting contracts, and supervision of construction operations. B-2835.

Experienced Designer; Assoc. M. Am. Soc. C.E.; 37; married; on water works and sewerage; has been with leading sanitary engineering firms; member A. W. W. A. Recently in responsible charge of design. C-6422.

Structural Engineer; Assoc. M. Am. Soc. C.E.; 34; married; 12 years experience in design of structural steel and concrete, industrial buildings, power plants, substations, and office buildings. Speaks Spanish fluently. Desires position. Location immaterial. C-1729.

Structural Engineer; Assoc. M. Am. Soc. C.E.; 37; married; graduate; state licenses; 10 years experience, surveying, design, and construction. Design, detail, and preparation of plans and specifications, on railroad, highway, parkway, harbor, and tall building structures. Completely familiar with the design of rigid-frame bridges. Available immediately. D-1496.

Structural Designer; Jun. Am. Soc. C.E.; 26; Arch. Engr. graduate of Iowa State College; Iowa state licensed; $3^1/_2$ years experience, designing all types of building construction, in architect's office. Available immediately. Location anywhere. D-2157.

Executive

Civil Engineer; Assoc. M. Am. Soc. C.E.; 33; married; 10 years varied construction experience, including $3^1/_2$ years on survey and construction of aids to aerial navigation for the U.S. Government in the South and Southwest; mine surveys; general construction and appraisal work; $2^1/_2$ years in charge of reinforced concrete construction in southern Cuba. D-2095.

Practical Civil Engineer; Assoc. M. Am. Soc. C.E.; 30 years experience on highways, sewers, drainage; topographic and hydrographic surveys; general engineering practice; 4 years in charge of highway maintenance; large system; many types; 7 years as chief engineer on large sewer construction program. Licensed professional engineer. Proved executive ability. Available May 15. D-2096.

Executive Structural Engineer and Estimator; Assoc. M. Am. Soc. C.E.; 39; graduate registered engineer; 19 years experience in design, drafting, estimating, and field construction, various types steel structures; power plants; coal handling; buildings, etc. Capacity to assume responsibility. Desires position with contractor, fabricator, erector, or architect. Salary moderate. Available for temporary or permanent connection, Metropolitan area. C-219.

Water-Works Engineer; M. Am. Soc. C.E.; 48; married. Can handle from design, purchase of materials and equipment, construction and placing in service. Filter, water softening, and steam power plants. All types of pumping equipment; storage dams; tanks; pipe lines; valuations, etc. Location anywhere. Perfect health. Best references. B-5581.

Bridge Engineer; Assoc. M. Am. Soc. C.E.; 35; married; graduate C.E.; licensed New York and New Jersey; 15 years experience in design and construction of bridges, both concrete and steel. Can take charge of borings, surveys, reports, investigations, estimates, designs, details, specifications, and construction. Best references. Available immediately. D-2112.

Reinforced Concrete Engineer and Concrete Technician; Jun. Am. Soc. C.E.; 32; married; B.S. in C.E.; 10 years experience in design and construction of pavements, bridges, and buildings, concrete control, sales promotion, office management. Desires position with architect, engineer contractor, or as cement manufacturer's field engineer. Available immediately. D-1926.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 30 years experience; chiefly specializing in food markets, cold storage, and refrigeration; has had considerable experience as general manager for sales division of electric refrigerators, domestic and commercial. D-1516.

Civil Engineer; Assoc. M. Am. Soc. C.E.; licensed professional engineer, New York State; 25 years experience in design and construction of steam and hydro-electric power plants, transmission lines of all capacities, including 220,000 volts, industrial plants, electric railways, valuations, estimates, specifications, and purchasing. Desires responsible charge of work. Location New York. B-5423.

Civil Engineer; Assoc. M. Am. Soc. C.E.; 41; married; graduate B.S. in C.E.; N.Y. State licensed professional engineer; 11 years experience as surveyor, inspector, estimator, assistant engineer, and superintendent on building and heavy construction; 10 years engineer and contractor, own business on building construction, bulk gasoline plants, and alterations. Location New York City. Available immediately. B-2044.

Executive Sanitary Engineer; M. Am. Soc. C.E.; 49; married; graduate C.E.; 18 years executive experience; broad experience in design, operation, and construction of water and sewerage works. Expert witness in sanitation and public health relative to water and sewage, also in water and sewerage works valuation. A-2785.

Engineer; M. Am. Soc. C.E.; graduate of Purdue University, 1930, with extensive and varied experience in railway and public utility design, construction, valuation, special investigations, and reports; seeks new engagement anywhere, preferably in the East. Record and references will prove creditable personal and professional qualifications. Salary reasonable, dependent on conditions and location. C-127.

Graduate Civil Engineer; Assoc. M. Am. Soc. C.E.; 41; married; licensed New York State; 19 years experience, field and office, all phases of engineering work; past 14 years in complete charge of engineering staffs, sales organizations handling reinforcing steel and allied products. Thoroughly competent executive, designer, estimator, detailer, production manager, sales promoter, organizer. Available for responsible position. D-1883.

Structural Engineer; M. Am. Soc. C.E. 45; married; with long successful record in steel business is looking for a responsible position. Extensive experience in fabricating business with estimating, designing, and sales. Offers exceptional qualifications. Desires opportunity of an interview or correspondence. C-5095.

Civil and Industrial Engineer; M. Am. Soc. C.E.; 40. Experience covers preliminary investigations, economic and financial reports and estimates, design and construction of utility and industrial steam and hydro-electric power plants, industrial and commercial developments, foundations, and hydraulic structures. Experience on supervision of contracts and solicitation of new business. C-6336.

Field Engineer; Assoc. M. Am. Soc. C.E.; 40; married; 8 years with consulting engineer on municipal work, surveys, paving, utilities, buildings, etc.; 1 year contractor's superintendent; 3 years with state highway department. Available in 2 weeks. Location immaterial but prefers the South. D-2149.

Junior

Junior Engineer; Jun. Am. Soc. C.E.; 24; single; B.S. in C.E.; student graduate of University of Illinois: expects M.S., C.E., in June; 14 months experience with Oregon State Highway Commission. Passed U.S. Civil Service Examination for junior engineer in 1931. Desires position in any branch of civil engineering, preferably structural. Available June 1. Location anywhere in the United States. D-2068.

Civil Engineer; Jun. Am. Soc. C.E.; 28; married; 8 years experience in surveying, drafting, and hydro-electric construction. Capable office man. Desires work in any capacity, especially in sanitary field. Location immaterial. C-3182.

Junior Civil Engineer; Jun. Am. Soc. C.E.; single; graduate of technical college in 1927. Some experience in highway, bridge, and field work. More experience in production, scheduling, costs, time study, statistics, labor requirements, charges, and prices in industry. Desires a location in plant or industry. Available immediately. Location immaterial. D-1875.

CIVIL AND STRUCTURAL ENGINEER; Jun. Am. Soc. C.E.; 26; married; honor graduate, Texas University, architectural engineering degree; $1^1/_2$ years experience in engineering department of structural steel company in South; $2^1/_2$ years office engineer and field work, Texas State Highway Department. Prefers position with consulting engineer or architect as structural designer. Location immaterial. Salary secondary. D-2085.

JUNIOR CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; single; M.S. in C.E., University of Minnesota; 2 years experience in university research and instruction. Desires teaching position or work in any branch of civil engineering. Location immaterial. Available immediately. D-2090.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; single; B.S. in C.E., Rutgers University, 1931, structural option; experience as assistant to instructor in summer surveying course. Desires work in any branch of civil engineering—preferably structural—field or office. Location and salary immaterial. D-2084.

JUNIOR CIVIL ENGINEER; Jun. Am. Soc. C.E.; 23; married; one child; graduated from University of Minnesota in 1932; 3 years experience in highway location, paving and grading, and as draftsman for the Concrete Steel Company. Now studying law by correspondence. Desires any position in engineering field. Location immaterial. D-2108.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; married; college graduate; licensed professional engineer; $5^3/_4$ years experience on survey, design, estimates, and construction; highways, bridges, sewers, pavement, land drainage, levees, and miscellaneous structures. Capacity for detail. Good references. Available immediately. Will consider anything. D-2107.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; single; B.S. in C.E. from University of Tennessee; has completed work for master's degree except thesis; member of Phi Kappa Phi and Tau Beta Pi; 2 years experience in location and construction, and 1 year in teaching. Any position acceptable. Location immaterial. D-2113.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 28; married; B.S. in C.E., University of Michigan, 1928; $4^1/_2$ years experience drafting, computing, and estimating in railroad engineering office; desires work in any branch of civil engineering. Available immediately. D-2119.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; single; B.S. in C.E., Rutgers University, 1930; $1^1/_2$ years as transitman in Essex County Highway Department; passed New Jersey State Civil Service senior draftsman examination. Desires working or teaching position in any branch of civil engineering, preferably one involving mathematics. D-663.

JUNIOR ENGINEER AND ACCOUNTANT; Jun. Am. Soc. C.E.; 25; single; B.S. in C.E.; 2 years experience in field party and on concrete, steel, waterproofing, excavation, and estimates on subway construction; 6 months experience on subway cost accounting. D-2086.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 29; married; $1^3/_4$ years as officer in U.S. Coast and Geodetic Survey; $1^1/_2$ years additional surveying and mapping in charge of party; $3^1/_2$ years drafting, structural detailing, and inspecting on bridges, municipal improvements, and highways. Will consider job any place, but prefer Western states. Available immediately. D-2122.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; married; graduate of Lehigh University, 1928; C.E. degree; Tau Beta Pi; 2 years as fieldman on sewer construction; 6 months as concrete draftsman; 1 year with Port of New York Authority on construction. Desires engineering or teaching position. Location immaterial. C-6787.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; B.S. in C.E.; $1^1/_2$ years experience, including highway design and construction, sewage disposal plant design, and surveying. Available immediately. C-7666.

FIELD ENGINEER; Jun. Am. Soc. C.E.; 25; single; C.E. degree, University of Cincinnati; 4 years experience on construction, inspection, and estimating on railroad terminal development. Available immediately. Salary and location secondary, provided the position offers a future. Position with consulting engineer on heavy construction desired. D-2133.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; single; B.S. in C.E., University of Alabama, 1931. Working knowledge of accounting and bookkeeping. Desires work in any branch of engineering. Location immaterial. Will accept modest salary on anything permanent with future prospects of advancement. Available immediately. D-2136.

GRADUATE CIVIL AND ELECTRICAL ENGINEER; Jun. Am. Soc. C.E.; 23; single; University of Michigan; 2 years practical experience with Bell system. Interested in structural, railway, and hydro-electric work. Open to anything in civil or electrical field. Free to travel. References. D-2144.

JUNIOR ENGINEER; Jun. Am. Soc. C.E.; 23; single. B.S. in C.E., New York University, 1931; some experience in construction, investigations, and reports. Desires any engineering position, particularly one with a future. Salary secondary. Location immaterial. D-2145.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; single; graduate of Rensselaer Polytechnic Institute, C.E., 1931; $2^1/_4$ years experience in highway design, survey, and construction with Suffolk County Highway Department (New York). Desires any engineering position. Location immaterial. Available immediately. D-2142.

GRADUATE CIVIL ENGINEER; Jun. Am. Soc. C.E.; 25; married; B.S. in C.E., Columbia University, 1932; Theta Xi; 6 months Government surveying experience; instrumentman for 4 months on building construction; 3 months in oil-plant and pipe-line construction and drafting work with responsible design. Desires anything connected with any branch of engineering. Salary and location open. D-2146.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 26; B.S. in C.E., New York University, 1930; 1 year on Holland Tunnel; $2^1/_2$ years as assistant engineer for general contractor on sub-river tunnels; draftsman, chief of party; hydrographic surveys, soundings, all studies; estimating, computing steel, concrete, waterproofing, etc.; building inspection, electric welding, building settlements. Desires work with contractor. D-1921.

CIVIL ENGINEER; Jun. Am. Soc. C.E.; 27; single; B.S.; M.S. in structural engineering; $1^1/_2$ years in steel fabricating shop; $2^1/_2$ years with architect on structural drafting and design; experience in small dwelling construction. Available immediately. Location immaterial. C-9297.

SALES

STRUCTURAL DESIGNER AND SALESMAN; M. Am. Soc. C.E.; 39; married; graduate C.E.; licensed; 18 years experience in structural designing, managing steel fabricating plant, and selling. Last 8 years head of consulting engineering office, specializing in structural designing for architects, owners, and contractors. Large acquaintance among architects and contractors in northern New Jersey. A-5489.

SALES MANAGER AND STRUCTURAL ENGINEER; Assoc. M. Am. Soc. C.E.; 39; married; graduate; high-class sales executive with long experience in sales and structural engineering, specializing in steel requirements for bridges and buildings. Seeking connection with building material manufacturer or general contractor. Qualified district sales manager. Good designer and estimator. Available soon. D-16.

TEACHING

ASSOCIATE PROFESSOR OF STRUCTURAL ENGINEERING; Assoc. M. Am. Soc. C.E.; married; degrees B.S., M.S., and C.E., University of Illinois; 3 years experience teaching major courses, structural theory, and design in ranking university; 5 years practice, reinforced concrete and steel structures—chiefly with Waddell and Hardesty, consultants—cantilever, arch, suspension, movable, and continuous-girder spans; technical writer; world-traveler. Desires position, leading university. D-330.

CIVIL ENGINEER; Assoc. M. Am. Soc. C.E.; married; B.S. in C.E., Massachusetts Institute of Technology; candidate this year for M.S. in C.E., Yale University; $10^1/_2$ years practical experience in design and construction of bridges, buildings, and dams; 9 years teaching structural engineering, concrete and descriptive geometry at leading university. Location in East preferred. B-3516.

RECENT BOOKS

New books of interest to Civil Engineers recently donated by the publishers to the Engineering Societies Library, will be found listed here. A comprehensive statement regarding the service which the Library makes available to members is to be found on page 87 of the Year Book for 1932. The statements made regarding the books are taken from the books themselves and this Society is not responsible for them.

AIRCRAFT YEAR BOOK FOR 1933. Compiled by Aeronautical Chamber of Commerce. New York, D. Van Nostrand Company, 1933. 506 pp., illus., diagrs., charts, maps, tables, 9 × 6 in., cloth, $6.

A comprehensive record, for reference, of the developments of the past year, covering commercial, manufacturing, and engineering progress.

ANALYSIS OF CONTINUOUS FRAMES BY THE METHOD OF RESTRAINING STIFFNESS. By E. B. Russell. San Francisco, W. H. Ellison and E. Russell, 1932. 46 pp., diagrs., charts, tables, 8 × 7 in., paper, no price given.

Description of a method of analysis that gives results directly, without the use of simultaneous equations or a series of approximations. Part I is concerned with members having constant moments of inertia throughout their lengths; Part II considers the general case where moments of inertia may vary throughout the length of the member. Basic equations are derived, tables are presented, and actual examples are given.

ARC-WELDED STEEL FRAME STRUCTURES. By G. D. Fish. New York and London, McGraw-Hill Book Company, 1933. 401 pp., illus., diagrs., charts, tables, 9 × 6 in., cloth, $5.

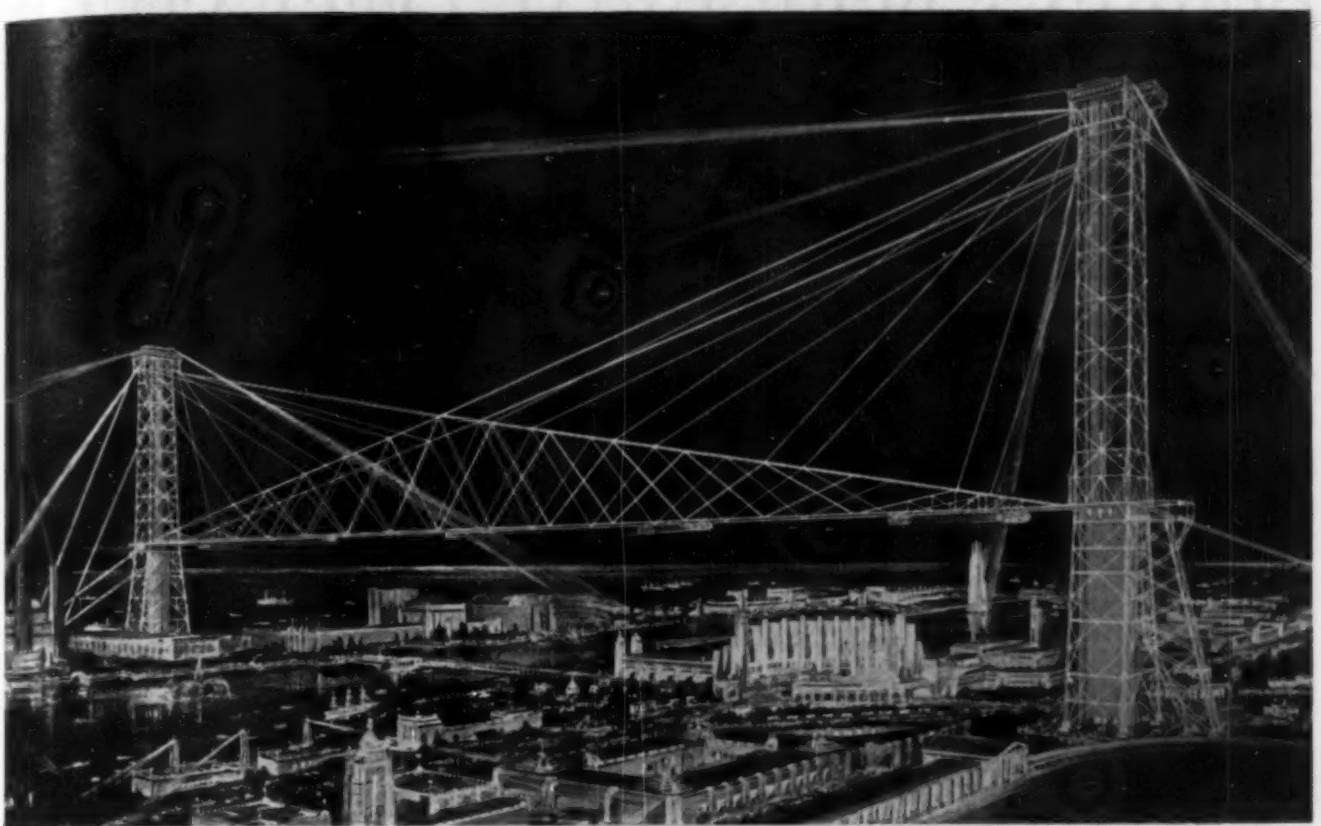
By a pioneer in the erection of welded bridges and buildings, who has directed the construction of most of those thus far built. The book includes a review of welded structures to date and discusses the arc-welding process, weld forms, the physical properties of welds, stress analysis, joint design, economy, construction methods, cost, estimating, shop drawings, supervision, and critical comment on some existing structures.

BERICHT ÜBER DIE KORROSIONSTAGUNG 1932, 17 Oct. Berlin, VDI-Verlag, 1933. 61 pp., illus., charts, diagrs., tables, 8 × 6 in., paper, 4 rm.

Papers from a conference on protection from corrosion by means of non-metallic coatings, dealing with the rôle of chemical reactions in corrosion, the influence of surface on the behavior of coatings, factors limiting the use of oil and nitrocellulose lacquers, enamel as a protection against corrosion, cement and concrete as rust preventives, phosphate rust-prevention processes, and rubber derivatives.

WATER PURIFICATION CONTROL. By E. S. Hopkins. Baltimore, Williams and Wilkins Company, 1932. 131 pp., illus., diagrs., charts, tables, 8 × 6 in., cloth, $1.75.

In brief, simple language this book discusses coagulation, sedimentation, filtration, and disinfection from the viewpoint of the operator.



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CURRENT PERIODICAL LITERATURE

Abstracts of Articles on Civil Engineering Subjects from Magazines in This Country and in Foreign Lands

Selected items from the current Civil Engineering Group of the Engineering Index Service, 29 West 39th Street, New York, N.Y. Every article indexed is on file in The Engineering Societies Library, one of the leading technical libraries of the world. Some 2,000 technical publications from 40 countries in 20 languages are received by the Library and are read, abstracted, and indexed by trained engineers. With the information given in the items which follow, you may obtain the article from your own files, from your local library, or direct from the publisher. Photoprints will be supplied by this library at the cost of reproduction, 25 cents per page, plus postage, or technical translations of the complete text may be obtained at cost.

BRIDGES

Bixby Creek Highway Bridge. A 320-Ft Concrete Arch on Scenic Route Along California Coast, S. Mitchell. *Eng. News-Rec.*, vol. 110, no. 15, April 13, 1933, pp. 467–470. Construction of the Bixby Creek highway bridge, about 15 miles south of the Monterey Peninsula, consisting chiefly of an open-spandrel arch of 320-ft span and 120-ft rise; construction of timber falsework 240 ft high; quantities and cost figures; record of settlement at highest bent of falsework.

California. Concrete-Arch Bridge Notable for Large Skew Angle, A. A. Eremin. *Eng. News-Rec.*, vol. 110, no. 13, March 30, 1933, p. 399. Main features of the concrete-arch highway bridge over the Gaviota Canyon between San Luis Obispo and Santa Barbara, Calif., built on a 57-deg skew angle; 100-ft clear span; costing $37,000.

Concrete Arch, Saskatchewan. New Concrete Bridge at Saskatoon Over South Saskatchewan River, C. J. Mackenzie. *Can. Engr.*, vol. 64, no. 12, March 21, 1933, pp. 5–9. Construction of concrete arch bridge, comprising five spans 125 to 202 ft in length, by relief labor under severe climatic conditions; restrictions on relief work.

Construction. Melting Ice Cakes Lower Steel Span on to Piers. *Construction Methods*, vol. 15, no. 3, March 1933, p. 15. Use of six 400-lb cakes of ice in place of jacks in lowering the 61-ton through-truss bridge across the Russian River on the Tahoe-Ukiah cut-off in California; each cake of ice supported about 20,000 lb.

Design. Concrete Bridge Slab Decks, G. D. Balsille. *Inst. Engrs. Australia—Journal*, vol. 4, no. 2, Feb. 1933, pp. 60–65. Analysis of general types of slab deck; practical tests; description of tests; slabs with fixed ends; slabs supported by joists; recommendations for design; past practice in light of present knowledge; suggestions for future investigation; bibliography.

Fort Snelling—Mendota, Minn. Shrinkage in Mendota Bridge, W. H. Wheeler. *Eng. News-Rec.*, vol. 110, no. 13, March 30, 1933, p. 415. Author's reply to a discussion of his paper entitled "Check Levels Made on Fort Snelling-Mendota Bridge," indexed in Engineering Index, 1932, p. 143, from the issue of Sept. 29, 1932.

Movable, Trolley Contacts. Electric Traction Power Contacts on Movable Railway Bridges. *Ry. Elec. Engr.*, vol. 24, no. 4, April 1933, pp. 74–77. New Haven has developed contact equipment for various types of drawbridges, which will work in all kinds of weather without causing radio interference.

Steel Girder. Shallow Bridge Permitted by Reinforced Gunite, E. W. Meckley. *Eng. News-Rec.*, vol. 110, no. 14, April 6, 1933, p. 430. Construction of a steel girder bridge over the Little Lehigh Creek, Allentown, Pa., consisting of twenty 22-in. beams of 53-ft span, lower flanges of which are strengthened with reinforcing rods, rods and girders being encased in gunite.

Steel Truss. New Steel Bridges in Macedonia, K. Kazambakas. *Texnika Xponika*, no. 28, Feb. 15, 1933, pp. 167–174. Structural characteristics of railroad bridges built recently in Macedonia by the Foundation Company.

Surveying. San Francisco-Oakland Bridge Base-Line Measurements, J. S. Bates. *West. Construction News and Highways Bldr.*, vol. 7, no. 5, March 10, 1933, pp. 122–124. Instruments and methods used; tension by spring balance unsatisfactory; method of marking tape lengths; adjustable marking table on tripod; procedure to minimize errors.

Suspension, Costs. Unit Prices—Connecticut River Bridge, Hartford. *Eng. News-Rec.*, vol. 110, no. 15, April 13, 1933, p. 486. Unit prices bid on new suspension bridge over the Connecticut River at Hartford; 7,500 ft long; the main span is a cable strand suspension bridge, with 856-ft center span and two 410-ft suspended side spans.

United States. Early American Bridges, L. N. Edwards. *Surveyor*, vol. 83, no. 2147, March 17, 1933, pp. 324 and 325. History of American bridges since 1787; wrought-iron suspension bridges; cast-iron arch and arch-truss bridges; cast-iron truss bridges. Delivered before the Newcomen Soc. for Study of History of Eng. and Tech.

Viaducts, Concrete Arch. Reinforced Concrete Viaducts at Valentine's Glen, Northern Ireland. *Structural Engr.*, vol. 11 (new series), no. 4, April 1933, pp. 198–199 and 202. Construction of railroad viaducts in Northern Ireland, comprising reinforced concrete arches up to 89 ft in span.

Welding. L.M.S. Bridge Reconstruction. *Engineer*, vol. 155, no. 4026, March 10, 1933, pp. 255 and 256. Example of reconstruction, in which electric welding was used with advantage, completed at South Tottenham, on the London, Midland, and Scottish Railway; viaduct is 3-span, double-track, continuous girder bridge, 190 ft long. Stringers and cross-girders were inadequate, so that replacement of whole deck became necessary; work was done without interference with normal traffic in either direction over bridge.

Widening. Widening Bridges on Old Federal Aid Project. *Contractors and Engrs. Monthly*, vol. 26, no. 3, March 1933, pp. 19–21. Widening a typical steel bridge; widening a concrete bridge; concreting crew; quantities and unit prices.

BUILDINGS

Earthquake Effects. Earthquake Design for Bank Buildings, P. F. Pape. *Eng. News-Rec.*, vol. 110, no. 15, April 13, 1933, pp. 457–460. Structural design of four new branches of Mitsui Bank in Japan, illustrating the application of modern earthquake-proof design practices. Continuous foundation mats, structural steel frames, reinforced concrete floors, walls and partitions, all tied together to act as a unit, comprise design basis. Foundation and superstructure details.

Exhibition Buildings, Chicago. Chicago Exhibition. *Engineer*, vol. 155, no. 4029, March 31, 1933, pp. 315–317. Notes on the World's Fair or international exposition to be held at Chicago from June to November, known officially as A Century of Progress Exposition; main buildings; steel and composition walls; suspended dome, 200 ft in diameter, for lofty circular hall or rotunda forming an annex of the Travel and Transport Building; agricultural buildings; United States and government buildings.

CITY AND REGIONAL PLANNING

Great Britain. Replanning of Built Areas in London, T. Adams. *Roy. Inst. Brit. Architects—Journal*, vol. 40, third series, no. 9, March 11, 1933, pp. 341–354. Improvements in London; lack of general plan; powers of Town and Country Planning Act; static areas; misunderstanding about zoning; where act could not apply; difficulty of preventing the erection of objectionable structures; preparing schemes under act. Before London Soc.

Industrial Districts. Location and Planning of Industrial Areas, W. C. K. Baumgarten. *City Planning*, vol. 9, no. 2, April 1933, pp. 49–72. Factors determining the location of industries; centralization vs. decentralization; area requirements of industries; railroad services in industrial districts; examples of planned industrial districts; recentralization possibilities. Before Am. City Planning Inst.

Present-Day Planning. Trends in Present-Day City and Regional Planning in United States, 1932, H. S. Buttenheim. *City Planning*, vol. 9, no. 2, April 1933, pp. 73–86. City planning as an economic source; contracted activity; expanded outlook; land-planning movement; our decreasing population growth; way out of slums; plans for more planning; new deal for leisure time.

CONCRETE

Aggregates, Transportation. How Railroads and Commercial Aggregate Producers Cooperate in Kansas, J. H. Ruckman. *Rock Products*, vol. 36, no. 3, March 25, 1933, pp. 28 and 29. Truck competition being met on sound lines; elements of costs developed and demonstrated; truck haulers disorganized; early railway efforts to meet truck competition; joint action to avoid ruinous competition.

California. Earthquake Again Proves Efficiency of Concrete Construction. *Concrete*, vol. 41, no. 4, April 1933, p. 9. California cities provide a test for all types of construction; investigators predict greater use of monolithic concrete and of cement mortar.

Construction. Need of Better Concrete, A. M. Bouillon. *Military Engr.*, vol. 25, no. 140, March–April 1933, pp. 127–132. Some recent bad practice; concrete curing and its purpose; permanence of old Roman concrete; selecting constituents; water-cement ratio; use of hydrated lime; importance of proper mixing; building forms; importance of cleaning. (To be continued.)

Culverts, Concrete. Small Concrete Works Under Field Service Conditions, J. W. Hay. *Structural Engr.*, vol. 11 (new series), no. 4, April 1933, pp. 176–178. Repair and modernization of masonry culverts at northwest frontier of India.

Curing. Concrete Strength Increased by Spray Irrigation, E. H. Burrows. *Eng. News-Rec.*, vol. 110, no. 13, March 30, 1933, pp. 401 and 402. Report on tests made at the Stony Gorge Dam near Orland, Calif., and the Rodriguez Dam near Tia Juana, Mexico, showing possibilities of producing higher-strength concrete by sprinkling; high pressure and fine spray heads create a mist surrounding fresh concrete.

Design and Practice. Economics in Concrete Design and Practice, M. G. Dempster. *Commonwealth Engr.*, vol. 20, no. 8, March 1, 1933, pp. 233–240. Results of Australian conclusions drawn from routine tests in which opportunities have arisen to test European and American statements.

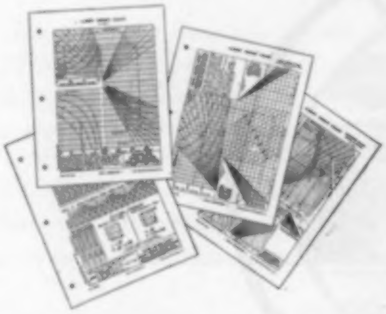
Dry Docks, Floating. Das Eisenbeton-Schwimmdock und das Slip der Mindener Eisenbeton-Werft, Minden, H. Schaare. *Schiffbau*, vol. 34, no. 2, Jan. 15, 1933, pp. 20–24. Reinforced concrete floating dock and slipway of a shipyard in Minden erected in 1921 for the building of reinforced concrete ships, and now being used for the repair of steel vessels.

Drying. Der Austrocknungsvorgang im Beton, E. Miething. *Zement*, vol. 22, no. 9, March 2, 1933, pp. 121 and 122. Drying process in concrete; results of elementary tests to give insight into moisture content of different layers of fine concrete bodies with different drying methods.

Hoover Dam Project, Construction. Mass Concrete Research for Hoover Dam, B. W. Steele. *Am. Concrete Inst.—Journal*, vol. 4, nos. 7 and 8, March–April 1933, pp. 305–317. Results of experimental research of mass concrete containing aggregates up to cobble size; volume change; foundation and contraction joint grouting; mass concrete strength and mix proportions; elastic properties of mass concrete; thermal properties of mass concrete; permeability.

Mixing. Coordination of Basic Principles of Concrete Mixtures—Chaps. XI and XII, J. A. Kitts. *Concrete*, vol. 41, nos. 3 and 4, March 1933, pp. 5–7, and April, pp. 13–15. March: Further review of Talbot-Richart method of proportioning and discussion of A.S.T.M. Series 201. April: Study of surface area, surface modulus, and fineness modulus of aggregates, which concludes review of mixture research.

Ready Mixed Concrete Plants. Engineer Versus Laboratory in Ready Mixed Plant Control, D. G. Dupuy. *Concrete*, vol. 41, no. 4, April 1933, pp. 7 and 8. Advantages and disadvantages of laboratory supervision; why plant



INDEX TO ADVERTISERS

INDUSTRIAL

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owner determined to engage engineer capable of designing concrete mixtures and controlling output.

REINFORCEMENT. New Type of Reinforcing Bar Develops High Bond Stress, C. J. Posey. *Eng. News-Rec.*, vol. 110, no. 15, April 13, 1933, p. 461. University of Iowa type of reinforcing bar, differing from existing types in that deformations are small and so closely spaced that they might properly be called crenulations.

STRESSES. Die wirtschaftliche Druckspannung des Eisenbetons, K. Bernhard. *Zement*, vol. 22, nos. 11 and 12, March 16, 1933, pp. 147–150, and March 23, pp. 158–160. Economic compressive stress of reinforced concrete; static conditions of unlimited pressure zone; economic compressive stress, not taking into consideration influence of natural weight; additional stress taking influence of weight into consideration.

UNITED STATES. Chicago Convention Summary. *Am. Concrete Inst.—Journal*, vol. 4, nos. 7 and 8, March–April 1933 (News Letter), pp. 2–13. Proceedings of the 1933 annual convention of the American Concrete Institute, including abstracts of papers and discussions on the vibration of concrete, architectural concrete, Hoover Dam construction, rigid-frame concrete bridges, etc.

VOLUME CHANGES. Volumetric Changes in Neat Cements and Mortars, R. E. Mills. *Am. Concrete Inst.—Journal*, vol. 4, nos. 7 and 8, March–April 1933, pp. 344–350. Results of a series of long-time tests begun in the Testing Materials Laboratory of Purdue University in the summer of 1924; change of volume with variations in temperature and moisture; change of weight, expansion, and contraction of neat cement beams and masonry mortar beams.

CONSTRUCTION INDUSTRY

COSTS. Unit Bid Summary. *West. Construction News and Highways Bldr.*, vol. 8, no. 6, March 25, 1933, pp. 160, 162, and 164. Unit costs bid on street and road work in Arizona, California, and New Mexico.

DAMS

AUSTRALIA. Mount Bold Storage. Adelaide Metropolitan Water Supply, J. H. O. Eaton and T. A. Farrent. *Inst. Engrs. Australia—Journal*, vol. 5, no. 2, Feb. 1933, pp. 47–56. Outline of proposed extension of water works of Adelaide, South Australia, involving construction of an overflow concrete arch dam; 138 ft maximum height; water cushion structure at toe of dam; and development of hydro-electric power from the dam.

CONCRETE, SPAIN. El hormigon de la presa del Esla. R. Rubio. *Ingenieria y Construccion*, vol. 11, no. 123, March 1933, pp. 117–120. Details of methods used for the concrete construction on a dam 90 m high, and requiring upward of 360,000 cu m of material in a hydro-electric project on the Esla River in Zamora Province; control of concrete through laboratory tests.

CONCRETE GRAVITY, FAILURES. Failure of Hydro-Power Storage Dam, S. E. Smith. *Can. Engr.*, vol. 64, no. 11, March 14, 1933, pp. 11 and 12. Analysis of the causes of failure of a concrete gravity dam, with maximum height of 32 ft, located near Port Arthur, Ont.

CONSTRUCTION. Heavy-Duty Construction Plant for Madden Dam Designed for High Salvage Value. *Construction Methods*, vol. 15, no. 3, March 1933, pp. 18–23. Construction plant designed to mix and place 500,000 cu yd of concrete for dam being built across the Chagres River at the Panama Canal; aerial tramway and screening plant; bulking plant; mixing plant; transportation of concrete.

HYDRAULIC STRUCTURES, CONCRETE CONSTRUCTION. Reinforced Concrete for Water-Retaining Structures (second paper), H. C. Ritchie. *Inst. Water Engrs.—Trans.*, vol. 37, 1932, pp. 63–94 (discussion) 95–106. Essentials of successful design; modular ratios; members in direct tension; members subjected to bending; case of T beams; contraction stresses; contraction joints; temperature stresses; expansion joints; impermeable concrete; improvements in method of construction; general survey of present position.

MASONRY, AUSTRALIA. Wyangala Dam on Lachlan River, N.S.W. *Water and Water Eng.*, vol. 35, no. 415, March 20, 1933, pp. 121 and 122. Main features of a granite masonry dam of the curved gravity type, 190 ft maximum height; also of a concrete ogee section, 1,000 ft long; total cost estimated at £1,352,000.

FLOW OF FLUIDS

WATER. Measurement of Water. *Water and Water Eng.*, vol. 35, no. 416, March 31, 1933, pp. 191–197. Design and operation of flumes, rectangular and V-notch weirs, level indicators, Venturi meter, large type meters, waste detection, domestic meters, leak detector.

FOUNDATIONS

RETAINING WALLS, DESIGN. Design of Retaining Wall, G. E. Cross. *Technique*, vol. 8, no. 2, Feb. 1933, pp. 53–58 and 62. Review of principles, illustrated with numerical examples. (In English.)

Modern Retaining Wall Construction, W. S. Wilson. *Surveyor*, vol. 83, no. 2147, March 17, 1933, pp. 317–319. Modern trend in retaining wall design and construction, showing a substantial relative economy in material, dead weight, and cost; numerical examples.

HYDRO-ELECTRIC POWER PLANTS

GREAT BRITAIN. Severn Barrage. *Engineer*, vol. 155, no. 4029, March 31, 1933, pp. 317–319, (discussion) 325. Review of report of expert coordinated subcommittee of Severn Barrage Committee; published by H. M. Stationery Office, London, price 15s net; selection of site; model experiments; situation above dam; floods, etc; effect of dam on railway connections; civil engineering works of dam; turbine dam; mechanical and electric equipment; secondary storage system.

HYDROLOGY, METEOROLOGY, AND SEISMOGRAPHY

ANEMOMETERS. Do You Use the Anemometer Correctly? F. T. Elder. *Heating and Vent.*, vol. 30, no. 3, March 1933, pp. 9–11. Use of anemometers for measuring air velocities inside buildings; construction; built-in errors; calibration; formulas; handling the instrument.

CALIFORNIA. Strong-Motion Records of Long Beach Earthquake, N. H. Heck. *Eng. News-Rec.*, vol. 110, no. 14, April 6, 1933, pp. 442 and 443. Records from three strong-motion accelerometers giving an indication of the acceleration produced by the southern California earthquake of March 10, 1933.

DROUGHT. Failure of Water Supply Caused Collapse of Early American Civilization, E. W. Lane. *Water Works Eng.*, vol. 86, no. 6, March 22, 1933, pp. 232–233, and 255. It now seems well established that the collapse of the civilization of the Cliff Dwellers in North America was brought about by the failure of their water supply in a prolonged drought, extending from the year A.D. 1276 to A.D. 1299; dates of civilization determined by tree rings.

EARTHQUAKES, CALIFORNIA. High Seismic Factors in Recent Earthquakes, L. H. Nishkian. *Eng. News-Rec.*, vol. 110, no. 15, April 13, 1933, p. 476. Rough calculations on damaged tension members in some structures indicate possible horizontal acceleration of 0.2 *g* or more; pile foundations; probable seismic factors.

EVAPORATION. Effect of Altitude on Evaporation, C. Rohwer. *Cornell Civ. Engr.*, vol. 41, no. 6, March 1933, pp. 94–96. Analysis of observations on the effect of altitude on evaporation at Fort Collins, Colo., and Mount Whitney, Calif.; derivation of formula.

METEOROLOGY. Symposium on Climatic Cycles. *Nat. Academy Sciences—Proc.*, vol. 19, no. 3, March 1933, pp. 349–388. Symposium consisting of the following papers: "Introductory Remarks," J. C. Merriam; "Evidences of Cycles in Tree Ring Records," A. E. Douglass; "Periodicity in Solar Variation," C. G. Abbot and A. M. Bond; "Nature of Solar Cycle," W. S. Adams and S. B. Nicholson; "Correlation of Sedimentary and Climatic Records," I. Bowman. Bibliography.

IRRIGATION

CHINA. Wei Pei Irrigation Work. *Far Eastern Rev.*, vol. 29, no. 2, Feb. 1933, pp. 60–71. History of irrigation in the Shensi Province since ancient times; details of project carried out by engineers of China International Famine Relief Commission; hydraulics of King River; remodeling of old canal; canal structures; bridges; new cut-off canal; canal reconstruction as work relief project.

MEXICO. Posibilidades de Almacenamiento en el Rio Principal de Tijuana, G. Landa. *Ingenieria*, vol. 7, no. 1, Jan. 1933, pp. 4–10. Study of storage possibilities on the principal river of Tijuana in the northwestern part of lower California; feasibility of irrigation project.

SEDIMENTATION. Settling Velocities of Gravel, Sand, and Silt Particles, W. W. Rubey. *Am. Journal Science*, vol. 25, no. 148, April 1933, pp. 325–338. Stoke's law and impact formula combined into a general equation for settling velocities of large and small grains. This general equation, which contains no empirical constants, accords very closely with the published data on quartz grains but not so closely with the data on fragments of galena. Bibliography.

LAND RECLAMATION AND DRAINAGE

GREAT BRITAIN. Land Drainage in England and Wales, J. C. A. Roseveare. *Inst. Water Engrs.—Trans.*, vol. 37, 1932, pp. 178–218 (discussion) 219–243. History of land drainage in Great Britain; drainage boards; Royal Commission on Land Drainage, 1927; Land Drainage Act, 1930; catchment boards; effect of Derating Act; reorganization of catchment areas; river gaging; run-off from catchment areas; flood of May 1932; drainage schemes in Ireland; construction of fascine mattresses; land reclamation; sea defences.

TENNESSEE. Land-Conservation Camp Plan and Tennessee River Basin, S. T. Henry and I. Foos. *Eng. News-Rec.*, vol. 110, no. 14, April 6, 1933, pp. 425–429. Main features of the plan for unemployment relief camps in the Federal forest reserves in the Tennessee River basin; water-power possibilities; navigation and flood control; forestation.

MATERIALS TESTING

BRICK CONSTRUCTION, REINFORCED. Reinforced Brickwork Tests, J. R. Shank. *Ohio State Univ.—Eng. Experiment Station News*, vol. 5, no. 1, Feb. 1933, pp. 1–3 and 13–14. Testing of reinforced brick beams at Claycraft Brick Company, 10 miles east of Columbus, Ohio.

PORTS AND MARITIME STRUCTURES

ANTWERP. Port of Antwerp. *Naut. Gas.*, vol. 123, no. 5, March 4, 1933, pp. 7–10. History of the port from the opening of the seventh century; geographical position; industries of Antwerp; port facilities; management and working of port.

BREMEN. Bremen. *Naut. Gas.*, vol. 123, no. 6, March 18, 1933, pp. 7–12 and 21. Most southern of ports on the German coast; special transfer facilities; extensive consolidated carload service; world's cotton and tobacco center; superior cargo-handling facilities; European grain center.

COAL HANDLING. First Great Coal Discharging Plants in Japan. *Far Eastern Rev.*, vol. 29, no. 1, Jan. 1933, pp. 35–37. Features of coal-handling equipment on the coal docks at Kawasaki, on the main canal connecting Tokyo and Yokohama, built in 1928; plant at Osaka, recently put into commission.

CONSTRUCTION EQUIPMENT. Cranes for Building Moles. *Mech. Handling*, vol. 20 (new series), no. 3, March 1933, pp. 77 and 78. Features of gantry cranes for handling masonry blocks over 30 tons in weight; discharging single blocks; lifting speed; steam-driven floating cranes.

FRANCE. Les travaux d'extension du port de Dunkerque, L. Gain. *Technique des Travaux*, vol. 9, no. 2, Feb. 1933, pp. 103–118. Report on extensions and improvements in the Port of Dunkerque, Northern France; sinking of caissons; construction of docks, revetments, bridges, etc.

OAKLAND, CALIF. Oakland's Modern Port Facilities, A. H. Abel. *Pac. Mar. Rev.*, vol. 30, no. 4, April 1933, pp. 97 and 98. Important features in terminal operation embodied in the design and layout of the port of Oakland.

ROADS AND STREETS

ASPHALT. Fluxed Asphaltic Limestone as Seal Coat for Mixed-in-Place Surfaces, J. H. Conzelman. *Pub. Works*, vol. 64, no. 3, March 1933, pp. 31 and 32. Placing a small amount of high-type bituminous paving mixture in surface voids and as a cushion over coarse aggregate.

BITUMINIZED CEMENT. "Sandwich" Type of Road Built with Bituminized Cement. *Construction Methods*, vol. 15, no. 3, March 1933, pp. 32 and 33. Construction of work relief road of Hampden, Mass., having a mortar layer of sand and bituminized cement "sandwiched" between the upper and lower courses of crushed stone.

CONCRETE. Pavement Base Strengthened to Keep Horizontal Plane, H. F. Clemmer. *Eng. News-Rec.*, vol. 108, no. 15, April 13, 1933, pp. 471 and 472. Concrete base on unstabilized subgrade designed to preserve level and elevation of bituminous surfacing in case of possible cracking or joint movement.

CONSTRUCTION. Problems of Surface Dressing, A. C. Hughes. *Surveyor*, vol. 83, no. 2145, March 3, 1933, pp. 269–271. Early dressings; penetration; use of covering grit; tar specifications; adhesive qualities; proprietary products; safety in use; bituminous emulsions; covering aggregate; size and grading; effect of moisture.

RURAL. Farm-to-Market Road Program, L. O. Marden. *Pub. Works*, vol. 64, no. 3, March 1933, p. 19. Two methods for providing good roads for rural communities; planning for secondary roads.

SOUTH CAROLINA. Tandem Pavers on 20.5-Mile Job in South Carolina. *Contractors and Engrs. Monthly*, vol. 26, no. 3, March 1933, pp. 13, 18, and 26. Use of tandem pavers equipped with special rigging at Inman, S. C.; jetting fills; preparing grade; batching aggregate and cement; running tandem pavers; hand finishing of slab; curing; water supplies; accounting.

TAR TREATMENT. Tar Surface Treatment of Low Cost Roads. *Pub. Roads*, vol. 14, no. 1, March 1933, pp. 1–20. Report of cooperative study by the Bureau of Public Roads and representatives of the tar industry; results of survey; bases used for surface treatment; construction of surface treatment; second application of tar; application of cover material; seal treatments; surface roughness; consistency of extracted bitumens; results of soil tests; subgrade soil con-

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stants; classification of soils; effects of surface treatments; performance of materials.

SEWERAGE AND SEWAGE DISPOSAL

Activated Sludge. Controlling Bulking of Activated Sludge, R. N. Clark. *Pub. Works*, vol. 64, no. 3, March 1933, pp. 37–38. Tests of use of ferric chloride to diminish bulking of settled activated sludge, run recently on plant with primary sedimentation, removing about 72 per cent of suspended solids, with activation for 7 hr, followed by clarification; chemical feedings; turbidity control; chemical mixing.

Great Britain. West Middlesex Sewerage Scheme. *Engineer*, vol. 155, no. 4027, March 17, 1933, pp. 278–280. Sewage disposal scheme in the course of construction. Area involved covers a watershed of 120,700 acres of the most densely populated suburban county in England. Sewage works proper are to be at Mogden, but the sludge produced is to be pumped up to Perry Oaks in an iron pipe to be dried out and digested to form what is hoped will be a marketable commodity.

Industrial Wastes. Experiences in Connection with Admission of Trade Wastes to Sewers, E. H. Staynes. *Surveyor*, vol. 83, no. 2147, March 17, 1933, pp. 327–328 (discussion) pp. 335–336. Experiences at Dewsbury, where practically all trade premises have been connected to sewers in recent years; treatment at sewage works; sludge disposal. Before Inst. Sewage Purification.

Maintenance and Repair. Copper Sulfate Treatment Kills Roots in Sewers, J. W. McAmis. *Water Works and Sewerage*, vol. 80, no. 3, March 1933, p. 102. Experience of Greenville, Tenn.

Philadelphia, Pa. Sewage Treatment with Ferrous Sulfate and Aeration, P. B. Streander. *Pub. Works*, vol. 64, no. 3, March 1933, p. 29. Experience with an experimental unit of from 20,000 to 30,000 gal per day capacity, constructed at the Northeast Sewage Treatment Plant, Philadelphia, consisting of a so-called flocculation tank having a detention period of between 20 and 30 min, precipitation tank providing settling-out period of between 45 and 60 min, and sand filter operating at a rate of between 1 and 1½ gal per min per sq ft of filter area, with a loss of head of about 12 in.

Sewage Analysis. Notes on Sewage Gas and Simple Method of Analysis, C. C. Agar. *Water Works and Sewerage*, vol. 80, no. 3, March 1933, pp. 99 and 100. Characteristics of hydrogen sulfide; simple method of gas analysis; determination of sulfide gas.

Sewage Tanks, Design. Feinsiebe in Absitzanlagen, R. Weldert and P. Sander. *Gesundheits-Ingenieur*, vol. 56, no. 1, Jan. 7, 1933, pp. 7–9. Report from Landesanstalt fuer Wasser, Boden- und Lufthygiene, Berlin-Dahlem, on use of fine screens for sedimentation tanks of sewage-disposal plants. Bibliography.

Sludge. Large-Scale Sludge Digestion Experiments at Baltimore, C. E. Keefer. *Water Works and Sewerage*, vol. 80, no. 3, March 1933, pp. 81–85. Additional data relating to the operation of heated separate sludge-digestion tanks; 1930 results from tank heated with hot water added direct to tank; 1931 results from tank heated with hot water coils; character of sludge. Bibliography.

Tunnels, Construction. Difficult Sewer Tunnel Built by Welfare Labor. W. P. Morse. *Eng. News-Rec.*, vol. 110, no. 12, March 23, 1933, pp. 376 and 377. Experience of Newton, Mass.; emergency form of cost-plus-fixed-fee contract used because of civil service restrictions on force-account work; distribution of labor; experienced men hired from outside.

United States. Fifteenth Annual Texas Water Works Short School. *Water Works and Sewerage*, vol. 80, no. 3, March 1933, pp. 97 and 98. Digest of papers on sewage topics: "Politics and Its Effect on City Government," J. N. Edy; "Current Practices in Sewage Disposal"; "Required Capacity of Separate Digestion Tanks for Activated Sludge Plant, Based on Operating Experience at San Antonio Sewage Plant," W. S. Stanley; "New Method of Sewage Disposal by Aeration, Coagulation, Clarification and Oxidation," C. C. Hays; "Coagulation with Ferric Chloride in Sewage Treatment," H. O. Banks; "Making Full Use of Theoretical Considerations in Water and Sewage Clarification," H. E. Schlenz; "Activated Carbon in Sewage Treatment," V. M. Ehlers; "Diffuser Mediums for Activated Sludge," F. C. Roe; "Sewage Irrigation," D. T. Mauldin.

STRUCTURAL ENGINEERING

Foundation. Recent Developments in Building, O. Faber. *Roy. Inst. British Arch.—Journal*, vol. 40, third series, no. 10, March 25, 1933, pp. 389–401; discussion, pp. 402–406. Review of recent research and practice in structural engineering, particularly testing of building foundations; features of Market Hall at Nairobi and concrete silos at Cardiff.

Joints, Wooden. Wood's Challenge, A. H. Oxholm. *Am. Forests*, vol. 39, no. 4, April 1933, pp. 166–168. Development of a new type of metal connector joint for wooden framework, opening up a large field of utilization of wood in structures, such as radio broadcasting towers, hangars, auditoriums, etc.

Walls, Earth. Protective Coverings for Rammed Earth Walls, R. L. Patty. *Agric. Eng.*, vol. 14, no. 3, March 1933, p. 70. Report from the Department of Agricultural Engineering of South Dakota State College on the use of paints as wall protection of pise-de-terre or rammed earth walls.

WATER TREATMENT

Activated Carbon. Evaluation of Powdered Activated Carbon for Water Works Use—Discussion, M. E. Flentje. *Water Works and Sewerage*, vol. 80, no. 3, March 1933, pp. 86–88. Methods of testing; direct and indirect methods; iodine test; phenol test; modifications of phenol test; effect of physical characteristics of carbon.

Australia Plant. Treatment Works, Rockhampton Water Supply, G. B. L. Symonds. *Inst. Engrs. Australia—Journal*, vol. 5, no. 2, Feb. 1933, pp. 37–46. Water treatment plant as installed at Rockhampton, Queensland, to treat 2,500,000 gal of water per day; method of operation; suitability and adaptability discussed in the light of 5 years operating experience.

Bacteriology of. Comparison of Three Methods of Determining Colon-Aerogenes Group, A. G. Nolte and W. A. Kramer. *Am. Water Works Assn.—Journal*, vol. 25, no. 3, March 1933, pp. 383–389. Comparative results with cyanide citrate agar, methylene blue, brom cresol purple medium and standard methods; method known as Dominick-Lauter's methylene blue brom cresol purple broth is simplest, quickest, and most reliable.

California. Water Treatment on Pacific Lines of Southern Pacific (More Especially Zeolite Treating), D. Wood. *Water Works and Sewerage*, vol. 80, no. 3, March 1933, pp. 92–94. First installation of zeolite softeners; installations for softening locomotive feed-water; results of treatment; characteristic waters softened. Bibliography.

Disinfection. Germicidal Effectiveness of Chlorine, Bromine, and Iodine, T. D. Beckwith and J. R. Moser. *Am. Water Works Assn.—Journal*, vol. 25, no. 3, March 1933, pp. 367–374. Report on study made at the Department of Bacteriology, University of California, of comparative effectiveness of three halogens; applications of as little as 0.1 ppm of each were followed by marked lethal efficiencies.

Filtration, Materials. Loss of Head and Backwashing Velocities for Anthracite Coal in Water Filters, H. G. Turner and G. S. Scott. *Water Works and Sewerage*, vol. 80, no. 2, Feb. 1933, pp. 66–68. Physical data for anthracites and sands; initial loss of head; backwashing velocities and filter bed expansion.

Filtration Plants, Equipment. Reinigung von Riesler- (Luefter) Steinen in Wasserwerken mit der Ziegelstein-Reinigungsmaschine, B. Haeber. *Gas und Wasserfach*, vol. 76, no. 7, Feb. 18, 1933, pp. 113 and 114. Description of electrically operated brushing and rinsing machines for cleaning porous brick used in water filtration plants.

Filtration Plants, Regulators. Leistungsregler in Filteranlagen, A. Kolibay. *Gesundheits-Ingenieur*, vol. 56, no. 1, Jan. 7, 1933, pp. 5–7. The design and operation of several designs of regulators of the float type.

Iodine Content. Iodine in Water Supply of Lexington, Kentucky, J. S. McHargue and D. W. Young. *Am. Water Works Assn.—Journal*, vol. 25, no. 3, March 1933, pp. 380–382. Contribution from the Department of Chemistry of Kentucky Agricultural Experiment Station, Lexington.

Iron Removal. Methods for Removal of Iron from Water Supplies, W. Donaldson. *Water Works Eng.*, vol. 86, no. 6, March 22, 1933, pp. 251 and 252. Demonstration of soluble iron in supply; simple operation of iron removal plant; removal by filtration through sand. Before Am. Water Works Assn.

Neutralization. Betriebserfahrungen mit einter Entsaeuerungsanlage "System Buecher," Daur. *Gas- und Wasserfach*, vol. 76, no. 11, March 25, 1933, pp. 199–203. Operating experience of the city of Pforzheim, Germany, with patented acid neutralizing installation known as the Buecher system; cost data also data on lime consumption.

Ohio Plant. New Water Plant Stresses Pre-Treatment, G. G. Dixon. *Eng. News-Rec.*, vol. 110, no. 13, March 30, 1933, pp. 395–399. Description of water purification and softening plant built by the Mahoning Valley Sanitary District to serve the cities of Youngstown and Niles, Ohio; preliminary treatment works; application of chemicals; flexibility in operation; settling basins; mixing chambers; recarbonation; equipment in head-house.

Screens. Fine Screening for Water Supplies, J. W. Cunningham. *West. Construction News and Highways Bldr.*, vol. 8, no. 5, March 10, 1933, pp. 135–136. Screening plants at Everett and Port Townsend, Wash., use 16-mesh bronze wire screens to remove fine solids from pulp-mill water supplies.

Settling Basins. Some Suggestions for Increasing Efficiency in Sedimentation Basins, F. P. Larmon. *Water Works Eng.*, vol. 86, no. 5, March 8, 1933, pp. 207 and 208. Experiments with retards, baffles, and inlets; methods showing best results; conclusions from observations.

Sludge Disposal. Tile Sludge Removal Systems for Water Treatment Plants, E. P. Schinman. *Water Works and Sewerage*, vol. 80, no. 3, March 1933, pp. 95 and 96. Reduction in number and size of basins; modification in water treatment; stream pollution decreased; prevention of sludge decomposition; flexibility in design and operation; negligible cost of operation.

Softening. Present Status of Municipal Water Softening, C. P. Hoover. *Am. Water Works Assn.—Journal*, vol. 25, no. 2, Feb. 1933, pp. 181–191. General review of advances in water softening; lime soda-softening problems; zeolite softening problems; choice of process. Bibliography.

Softening Plant. Water Softening Plant at Western Springs, Illinois, D. H. Maxwell. *Water Works and Sewerage*, vol. 80, no. 3, March 1933, pp. 105–108. Method of treating water having a total hardness of 900 parts per million; quality of well water; water treatment investigation; selection of process; plant design; aeration; chemical feed; rapid mix; slow mix; clarifier; carbonating basin; CO_2 generating plant; filters; high lift pumps; arrangement for washing filters; wash water cistern; operating schedule; plant cost.

Uncovered Reservoir. Experiences with Well Water in Uncovered Reservoir, K. W. Brown. *Am. Water Works Assn.—Journal*, vol. 25, no. 3, March 1933, pp. 337–342. Experience with water stored in an uncovered reservoir at Stockton, Calif.; trouble with blood worms; trouble with iron bacteria.

Winnetka, Ill., Plant. Mechanical Agitation by Motor Driven Paddles at Winnetka, Ill., C. Leipold. *Water Works and Sewerage*, vol. 80, no. 3, March 1933, pp. 103 and 104. Description of new plant extension having 6 mixing basins with a combined capacity of 121,000 gal with a total nominal retention period of 30 min at plant capacity; operations of mixing basins between periods of cleaning basins.

WATER WORKS ENGINEERING

Distribution Systems. Wasserscheidepunkte in Wasserrohrnetzen, G. J. Lehr. *Gesundheits-Ingenieur*, vol. 56, no. 2, Jan. 14, 1933, pp. 13–16. Study of water divide points in water distribution network; mathematical analysis and graphs.

Germany. Ueber die Wasserversorgung von Karlsruhe, K. Eglinger. *Gas- und Wasserfach*, vol. 76, no. 10, March. 11, 1933, pp. 185–188. Description of the water works of the city of Karlsruhe, Germany.

Hydrants, Standardization. Suggestions for Standardization of Fire Hydrant Markings, S. S. Anthony. *Water Works Eng.*, vol. 86, no. 6, March 22, 1933, p. 231. Text of standards proposed by the Committee of the Maine Water Utilities Association. Before the New England Water Works Assn.

Laws and Legislation. Court Decisions in Cases Involving Rights of Water Works Employees, L. T. Parker. *Water Works Eng.*, vol. 86, no. 7, April 5, 1933, pp. 284 and 285. Recent court decisions treating with the removal of an officer without notification, appointment ordinance, proof to dismiss intoxicated employees, breach of official bond, etc.

Malaya. Water Supply of Malaya, W. Buchler. *Water and Water Eng.*, vol. 35, no. 415, March 20, 1933, pp. 122–125. Review of water works, including purification and pumping plant, with special reference to those of Johore and Singapore.

Management. Round Table. *Water Works Eng.*, vol. 86, no. 7, April 5, 1933, pp. 286–288. Discussion by practical water engineers and superintendents; offsetting the downward trend of income; methods taken to increase revenues without recourse to rate increases.

Rate Making. Rate Making Under Present Economic Conditions, N. T. Veatch, Jr. *Am. Water Works Assn.—Journal*, vol. 25, no. 3, March 1933, pp. 343–354. General requirements for water works rate-making; rate base; valuation; going value and development cost; operating expenses; fire protection; outside consumers.

Water Towers, Design. Architecture Applied to Elevated Steel Tanks. *Eng. News-Rec.*, vol. 110, no. 13, March 30, 1933, pp. 403–406. Structural and architectural features of the recently completed water towers of Baltimore, Md., and Tallahassee, Fla.; 300,000-gal and 4,000,000-gal capacity, showing improved appearance due to special architectural treatment.

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